Betts & Bond

Experiments with Various
Types of Gasoline Engines

Mech. Engineering B. S.

1905



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EXPERIMENTS WITH VARIOUS TYPES OF GASOLINE ENGINES

BY

DAVID ROY BETTS

AND
JOHN MYRON BOND

THESIS FOR THE DEGREE OF BACHELOR OF SCIENCE
IN MECHANICAL ENGINEERING

IN THE
COLLEGE OF ENGINEERING
OF THE
UNIVERSITY OF ILLINOIS
PRESENTED JUNE, 1905



UNIVERSITY OF ILLINOIS

May 26, 1905 190

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

DAVID ROY BETTS and JOHN MYRON BOND

ENTITLED EXPERIMENTS WITH VARIOUS TYPES OF GASOLENE ENGINES

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

or Bachelor of Science in Mechanical Engineering

HEAD OF DEPARTMENT OF Mechanical Engineering

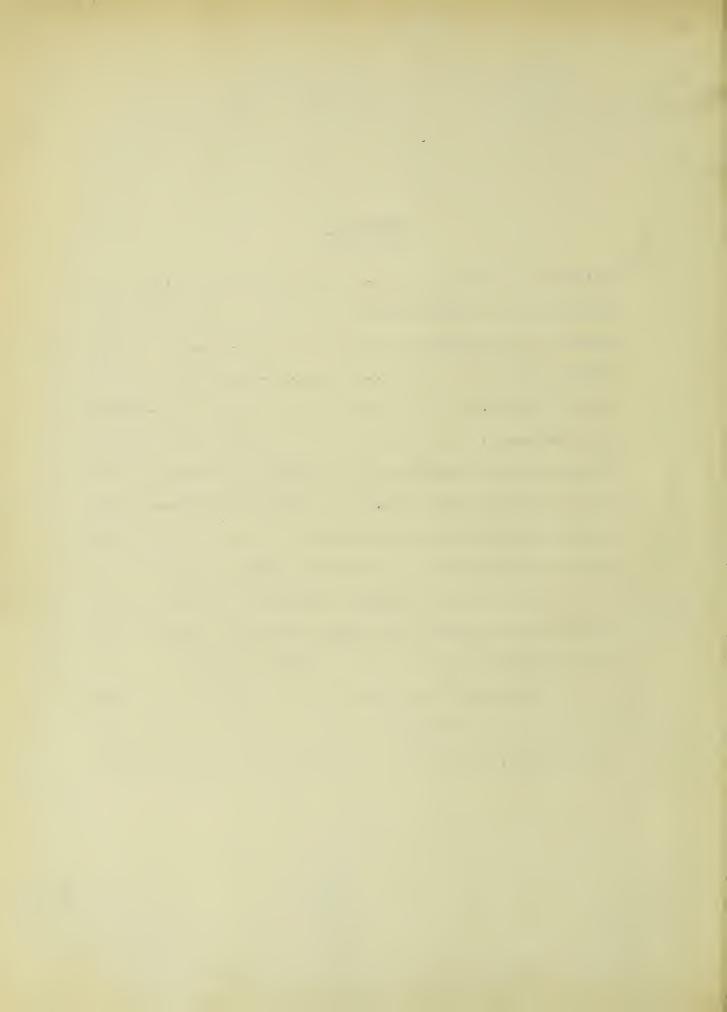
P. Brickennage

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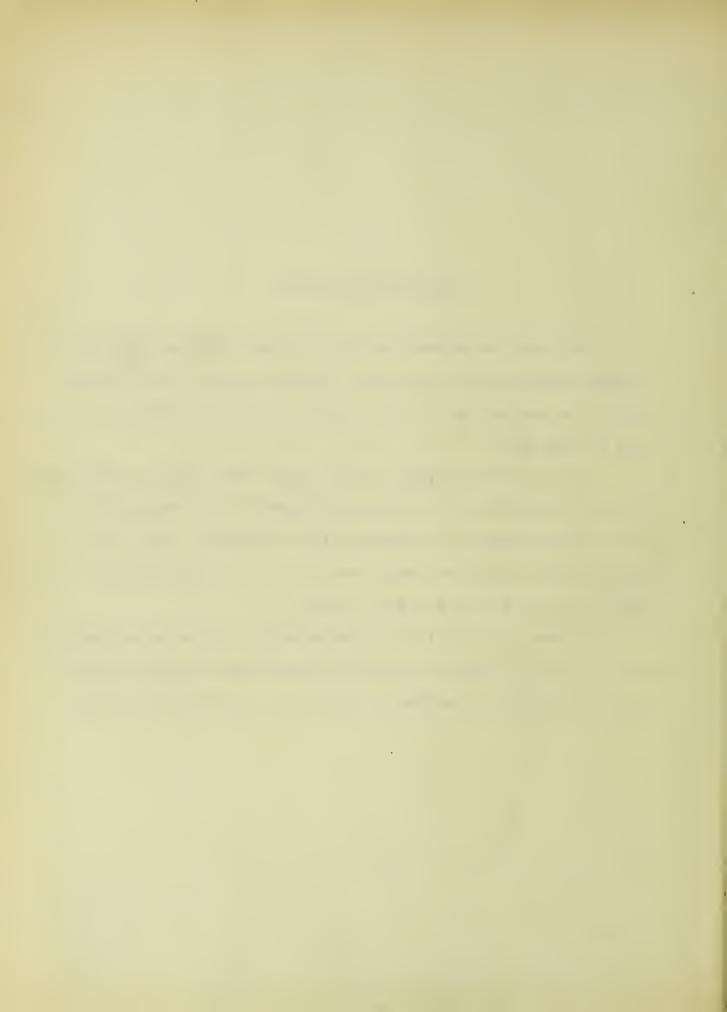


PRELIMINARY REMARKS.

As gasoline engines are becoming more and more important as prime movers and as data upon gasoline engine tests is very scarce, we decided to run the following tests and obtain as much data as possible.

All the tests given in this report were made by the writers on a Ten Horse Power Otto Gasoline Engine in the mechanical engineering laboratory of the University of Illinois. Two, tests beginning with a friction load, were run for each horse power to as high a load as the engine would carry.

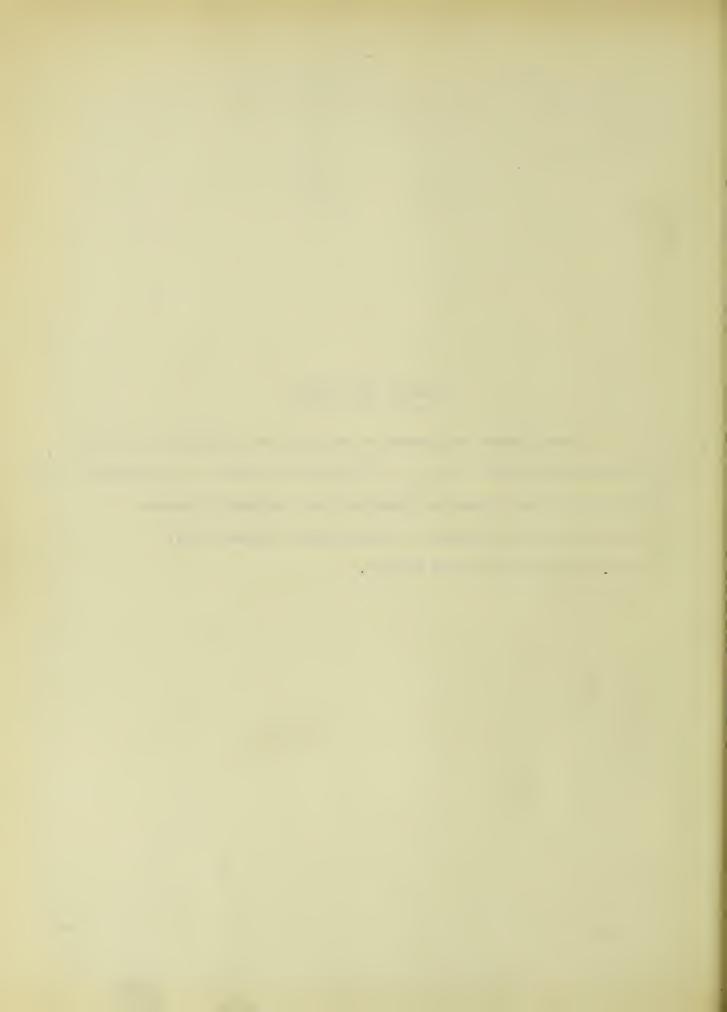
It was our object to add some tests made on other machines but from lack of time we decided to work this data up carefully and have it reliable instead of more data but not so reliable.



PURPOSE OF TESTS.

These tests were made to obtain the following results:

- (a) Cost, per brake horse power hour, for fuel, at different loads.
- (b) Porportion of air to gasoline for different loads.
- (c) Mechanical, thermal and potential efficiencies.
- (d) Heat balance of the engine.



DESCRIPTION OF APPARATUS.

The Engine.

"Otto" ten horse power gasoline engine shown in photos, as installed in the mechanical engineering laboratory of the University of Illinois. This engine is rather old and at times considerable difficulty was experienced in making it run, due to water leaking into the cylinder. The oil used for lubrication outside of the cylinder was engine oil used for lubricating the engines in this laboratory. The oil used in the cylinder to lubricate the piston was a special gasoline engine oil with a high flash point.

Sparking Device.

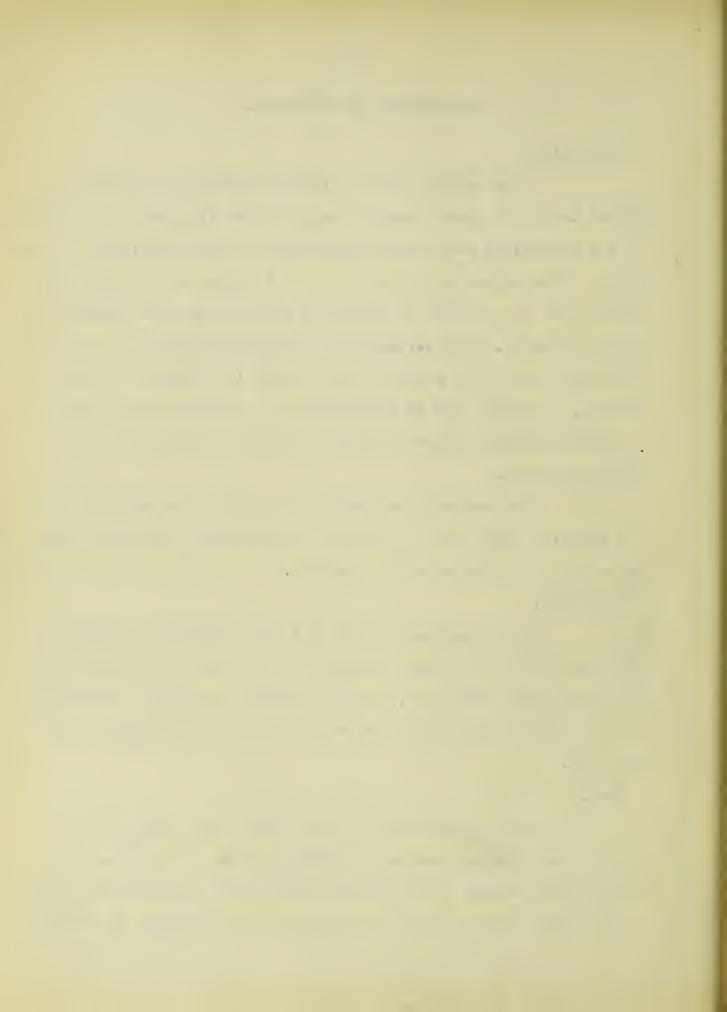
The method of exploding the gas in the cylinder was by the electric spark made by several dry batteries and a viorator connected to the poles of the machine.

Indicator.

The indicator used in all these tests was a Crosby gas engine indicator with a piston of 1-4 square inch area and a 120 pound spring was used. As the ordinary indicator piston has an area of 1-2 square inch, we will say that a 240 pound spring was used.

Fuel.

The gasoline used in all these tests was kept in a five gallon gasoline can on a box which rested on scales. The spout at the bottom of the can was right over the gasoline reservoir of the engine so that gasoline could be let into it without



was one on which we could weigh to hundredths of a pound, so the gasoline would be measured accurately. In a few tests a less accurate scale was used owing to the fact that this scale was in use for other work.

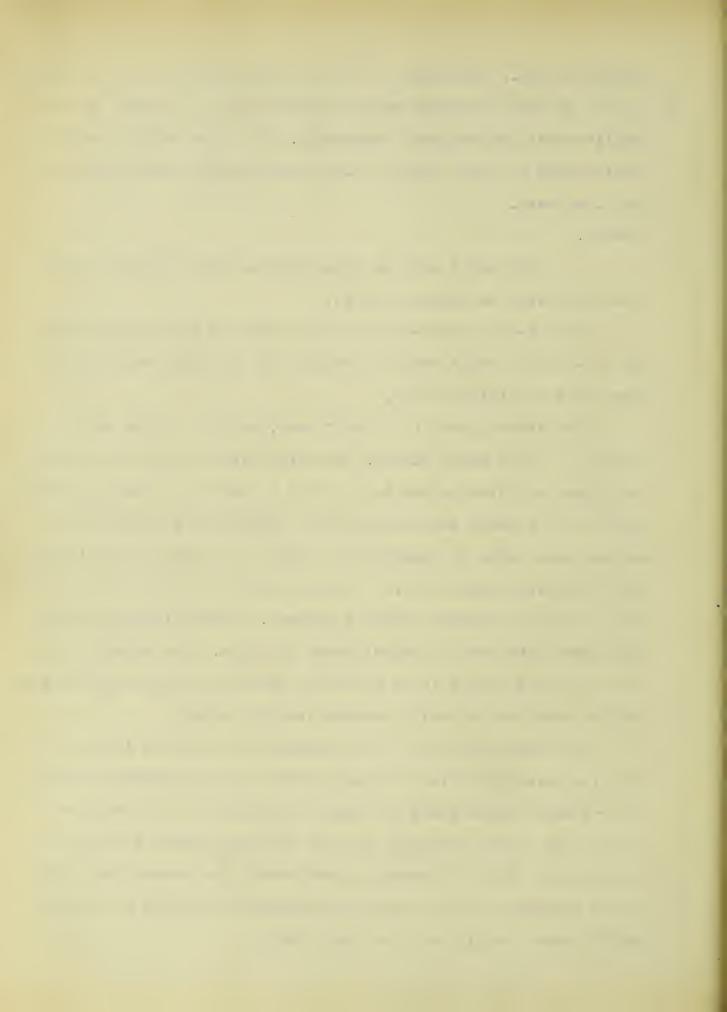
Brake.

The brake used to determine the brake horse power is shown in photos on pages 52 and 57.

A cast-iron water-cooled brake wheel 20 inches in diameter and 4 1-8 inches wide was made to bolt to the fly wheel to use in place of the driving pulley.

The brake shoes are of soft wood, (poplar in this case) backed by 1 inch maple pieces. The brake arm is built up of 3-4 inch pipe and fittings and is fastened to the brake-shoes by floor flanges. The lower shoe is connected rigidly to the brake arm, and the upper shoe is connected by means of a right and left nipple, which is a loose fit in both the tee and the floor flange so that it may be adjusted with the fingers. A bolt through the vertical pipe connects all rigidly when in place. The object of the right and left nipple is to allow for wear on the shoes and to permit the brake to be easily removed from the wheel.

The shoes are built up of material 1-2 and 1-4 inches thick, alternating: The 1-2 inch strips form the bearing surface, the 1-4 inch strips being cut away for about 1-2 inch from the wheel. The strips are also slightly inclined across the face of the shoe, so that the bearing is not continuous across its width, but is a series of bands slightly slanted, the object of this being to insure smooth and even lubrication.



Air.

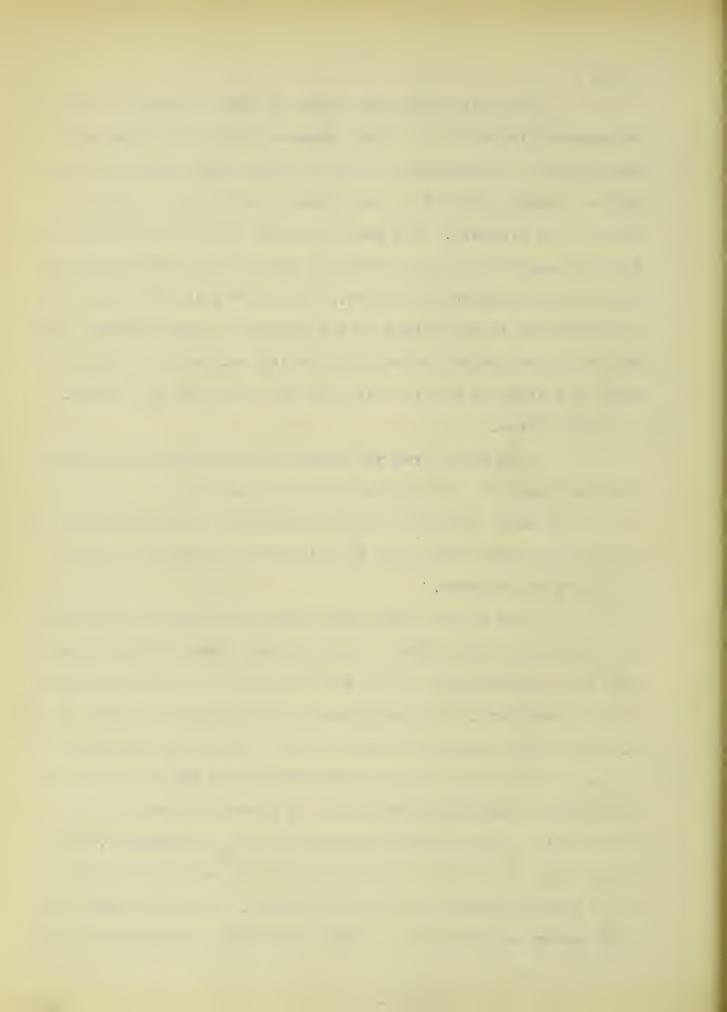
The air compressor shown in photo on page was used to compress the air in the high pressure air tank, shown in the same photo, to a pressure of about eighty pounds gage. This air was led through pipts to a low pressure tank which was kept at atmospheric pressure. The cubic capacity of the high pressure air tank is about ninety cupic feet and that of the low pressure air tank is about twelve cupic feet. The air was led from this low pressure tank to the intake of the engine by pipes in which there was two quick opening valves, one to let outside air into the pipe, the other to let the air from the tank into the engine. Cooling Water.

The water from the jacket used to keep the cylinder cool was piped to a tank which rested on scales.

The water from the exhaust calorimeter, used in cooling the exhaust gases was also piped to a tank which rested on scales.

Exhaust Calorimeter.

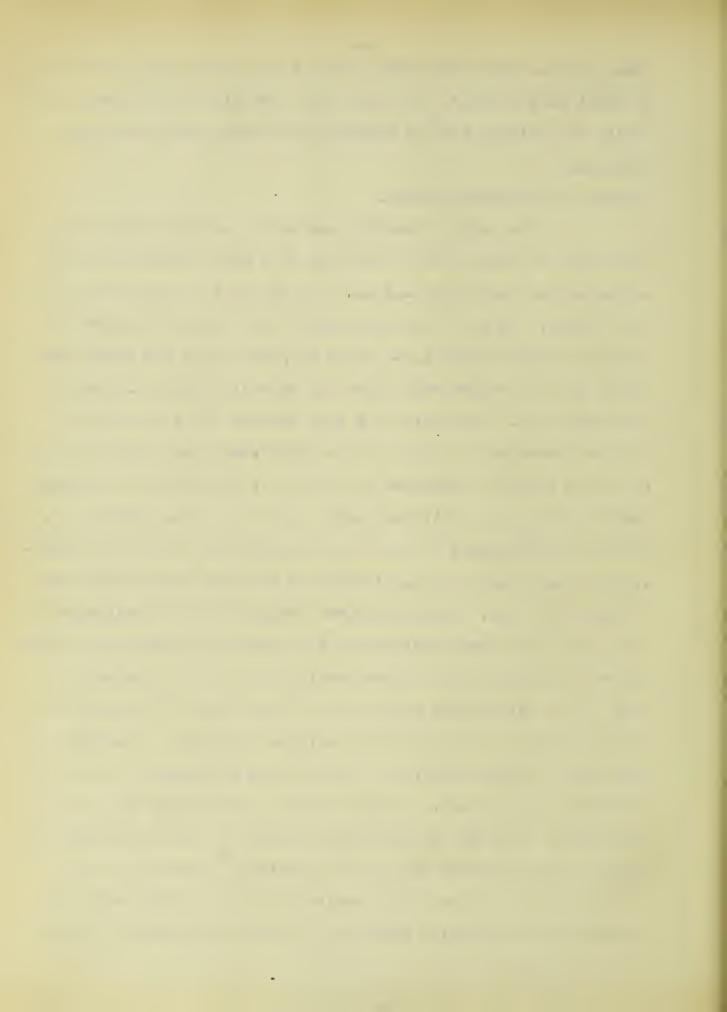
The exhaust gases were conveyed through a pipe from the exhaust of the engine to a feed water heater fitted up to be used as a calorimeter to cool the exhaust gas to the temperature of the atmosphere. This calorimeter is shown in the photo on page 54.A feed water heater was used for this purpose and was covered on the outside with aspestos and mineral wool two inches thick, and the pipe connections were made as shown in photo and were covered with aspestos from the engine to the calorimeter. The method used is to send the exhaust gases through and around some tubes through which cold water is flowing. The cold water and gases never came together as there was always a thin tube between



them, but the heat would pass from the hot gases through the sheet of metal to the water. The water was then piped to the tank on scales and weighed and the exhaust gases were piped out of the building.

Manner of Conducting Tests.

The weights were all put on the safety valve of the compressor so that it would compress to a high pressure and all valves except the one in the pipe leading to the low pressure tank were closed. As soon as the compressor had run the pressure in the high pressure tank up to 75 or 80 pounds gage the valve leading to the compressor was closed and this air held till time to start the test. The engine was then started and the indicator passage opened once or twice to see that there was nothing caught in it and then the indicator was attached. The water was started running through the cylinder jacket and through the calorimeter. One man was stationed at the high pressure tank to read the pressure and temperature of the air when he blew the whistle for them to start the test. Another man was stationed at the indicator to take cards every two minutes when the whistle was blown and another man was stationed at the valve leading to the low pressure air tank and he watched the manometer in it and kept the pressure in the tank the same as that of the outside atmosphere. Another man was given a speed counter and stationed at the machine to take the revolutions per minute. Another man was stationed at the exhaust calorimeter to count the explosions because we found that the electric explosion counter would skip sometimes. Another man was stationed at the tanks on the scales to read the temperature of the entering and leaving waters and to weigh the amount from the



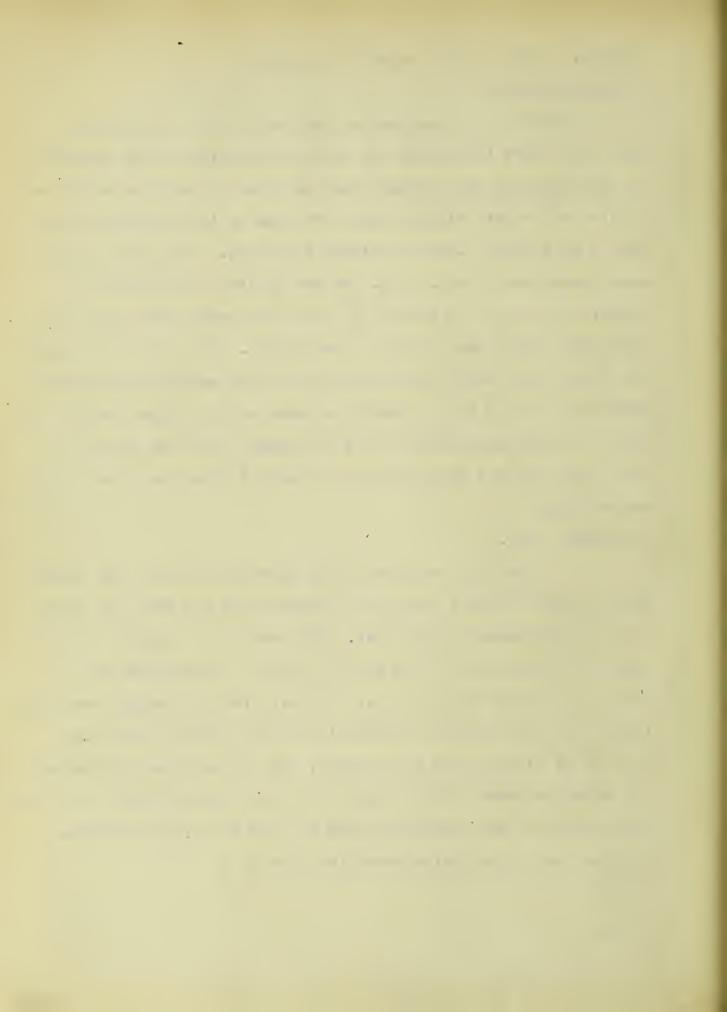
cylinder jacket and the exhaust calorimeter.

Starting Test.

When the test was started the man at the high pressure tank would give the signal and take the temperature and pressure in the high pressure air tank and then blow the whistle every two minutes and record similar data. The man at the indicator would take a card every time the whistle was blown. The man at the fly wheel would take the R. P. M. for one minute every time the whistle was blown and the man at the calorimeter would count the explosions every time he heard the whistle. The man at the weighing tanks would take the temperatures of the entering and leaving waters and at the first whistle he would put the pipes leading the water from the calorimeter and the cylinder into the tanks which were empty and had been weighed so that all water would be caught and weighed.

Stopping Test.

When the pressure in the storage tank got down pretty low the leader plew a signal to stop the test and read the pressure and temperature of this air. The man at the weighing tanks pulled the pipes out of the tanks, read the temperature and weighed the water in each tank. The air from the outside was then turned into the engine, the gasoline in the engine supply pipe brought up to the point of starting, the gasoline can weighed and the amount of gasoline used during the test was obtained. The gasoline supply to the engine was shut off and the engine stopped. The lupricating oil drips were also closed.



ENGINE DATA.

1.	Name of Engine
2.	Manufactured by
	Philadelphia, Pennsylvania.
3.	Number of CyclesFour.
4.	Kind of fuel used
5.	Heat of combustion#1, gasoline, 19,130
	#2, gasoline, 19,263 B. t. u. per lb.
6.	Rated horse power
7.	Floor space occupied
8.	Number of cylinders
9.	Bore of cylinder 5 3-4".
10.	Stroke of piston
11.	Volume of cylinder
12.	Clearance107 cu. in.
13.	Diameter of flywheels4'-8".
14.	Rated revolutions per minute333 R. P. M.
15.	Kind of governor
16.	Kind of ignition
17.	Kind of valvesPoppet.

•

EXPLANATION OF METHODS OF CALCULATING RESULTS.

Fuel: - The weight of the can of gasoline before and after each test was known and by subtracting we obtained the amount used. All tests before April 17, 1905 were run with the same gasoline which was analyzed by Prof. Parr of the chemistry department and an average of six analyses showed that the heating value of the fuel was 19,120 B.t.u. per pound. All tests on and after April 17, were run with a gasoline which was analyzed by Prof. Parr and an average of two analyses showed a heating value of 19,263 B.t.u. per pound.

In our calculations when it was desired to have the amount of gasoline per explosion the total amount of gasoline used during the test was divided by the number of minutes the test lasted and that result by the average number of explosions per minute during the test. When the volume of vapor of the gasoline was required, the weight in pounds was multiplied by 3.46 which gave the vapor volume in cubic feet.

Cooling water: The weight of the tanks were known and after the test was stopped they were weighed and the difference gave the weight of water. The difference in temperature was also known and as it takes 1 B.t.u. to raise one pound of water from 59° to 60°F we multiplied the number of pounds of water by the number of degrees rise in temperature. As the temperatures were pretty close to 60°F we made no corrections for temperatures.

Air:- The method of calculating the air used was as follows:

$$M = P V.$$

$$R. T.$$

Where P = Pressure in pounds per square foot.

- " V = Volume of air in cubic feet.
- " M = Mass of air in pounds.
- R = A constant, = 53.18.
- T = Absolute temperature

by calibration to be 90.83 cubic feet. To find the amount of air used in any certain time, M for the beginning and end was figured and subtracting, we obtained the weight in pounds for that time. If it was desired to reduce this to cubic feet the pounds were multiplied by 13.4 as this is the volume of air per pound at 75°F and atmospheric pressure.

Brake Horse Power: - The brake horse power was figured from the formula; - $\frac{2\pi \text{ a W N}}{33,000 \text{ X } 12}$ = B. H. P.

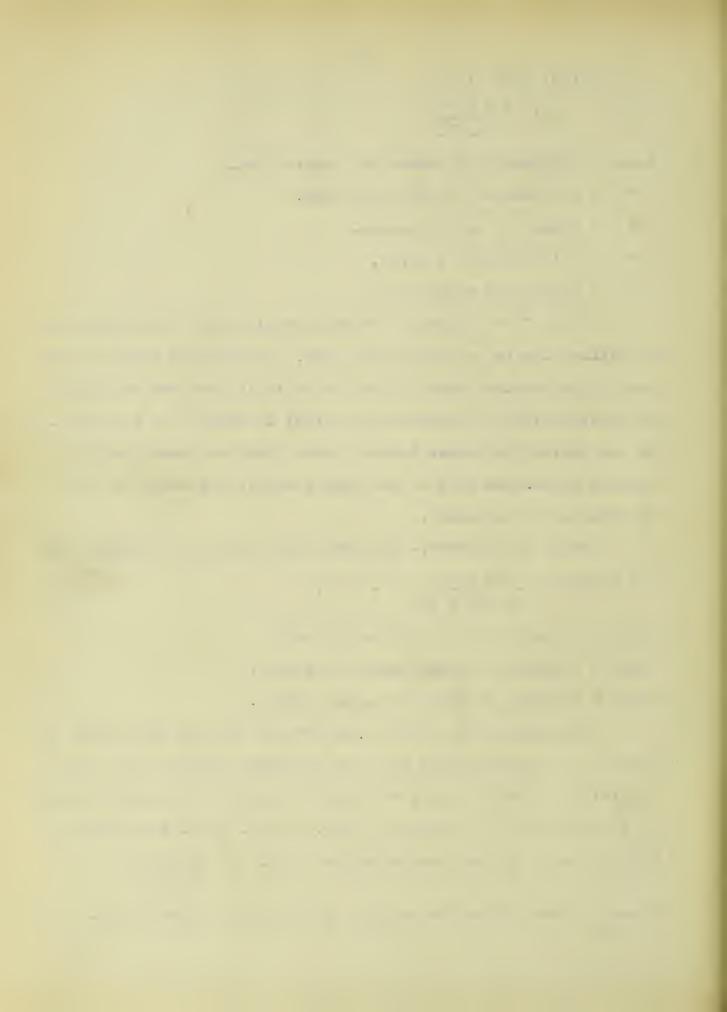
Where a = length of brake arm = 62 1-2".

Where W = weight on prake scales in pounds.

Where N = number of revolutions per minute.

Indicated Horse Power:- The area of the card was found by means of a planimeter and the mean effective pressure was found by dividing this area by the length of the card and by multiplying by the strength of the spring = 240. The I. H. P. was then figured for each card by the formula;- I. H. P. = $\frac{P + 1}{33,000}$

Where P = mean effective pressure in pounds per square inch.



Where l = length of stroke in feet.

Where a = area of piston in square inches.

Where n = number of explosions per minute at time card was taken.

Mechanical Efficiency:-

B. H. P. = Brake Horse Power = Mechanical Efficiency.

I. H. P. Indicated Horse Power

Thermo-dynamic Efficiency:- This efficiency was found by transferring one average card to the temperature volume plane by the method given in Reeve's Thermo-dynamics p 72-82, and dividing the area of the transferred card by the total heat area.

Potential Efficiency: - The potential efficiency =

The actual efficiency = the area of the transferred card divided
The ideal efficiency

by the area the card should have to be a perfect one theoretically.

Heat Balance: - The heat was used in the following ways: -

- (1) Doing work.
- (2) Heat lost to jacket water.
- (3) Lost to exhaust.
- (4) Lost to radiation.
- (1) = I. H. P. X 33,000 X duration of test in minutes : 778.
- (2) = heat determined as lost to jacket cooling water.
- (3) = heat obtained in the calorimeter water.
- (4) = 100 (1 + 2 + 3)

CONCLUSION.

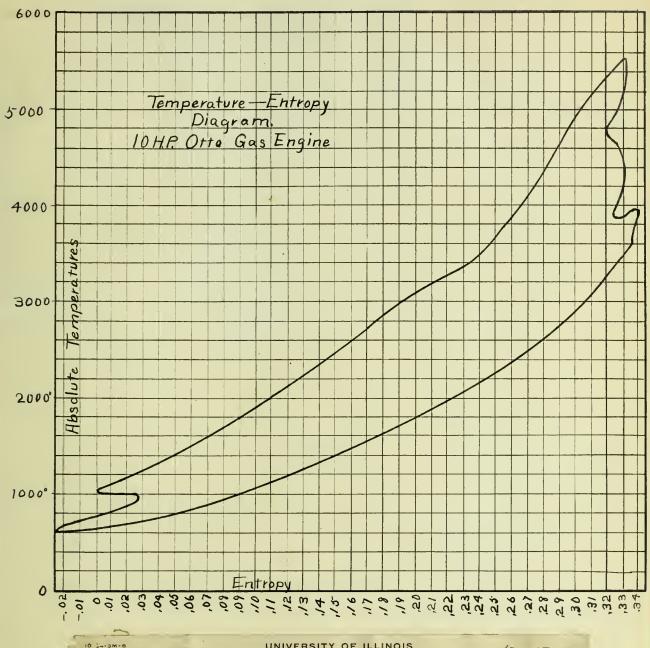
As a result of these tests we find that this engine works very well and requires very little attendance.

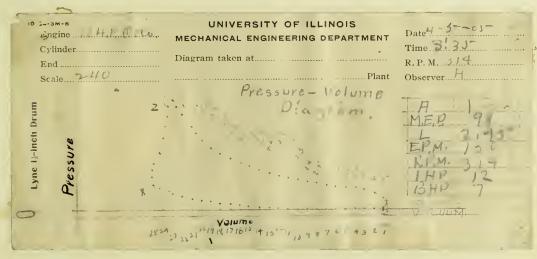
The most economical point of operation is at seven brake horse power. Ten brake horse power could not be obtained from the engine as the revolutions would immediately decrease when the brake load was raised above nine horse power.

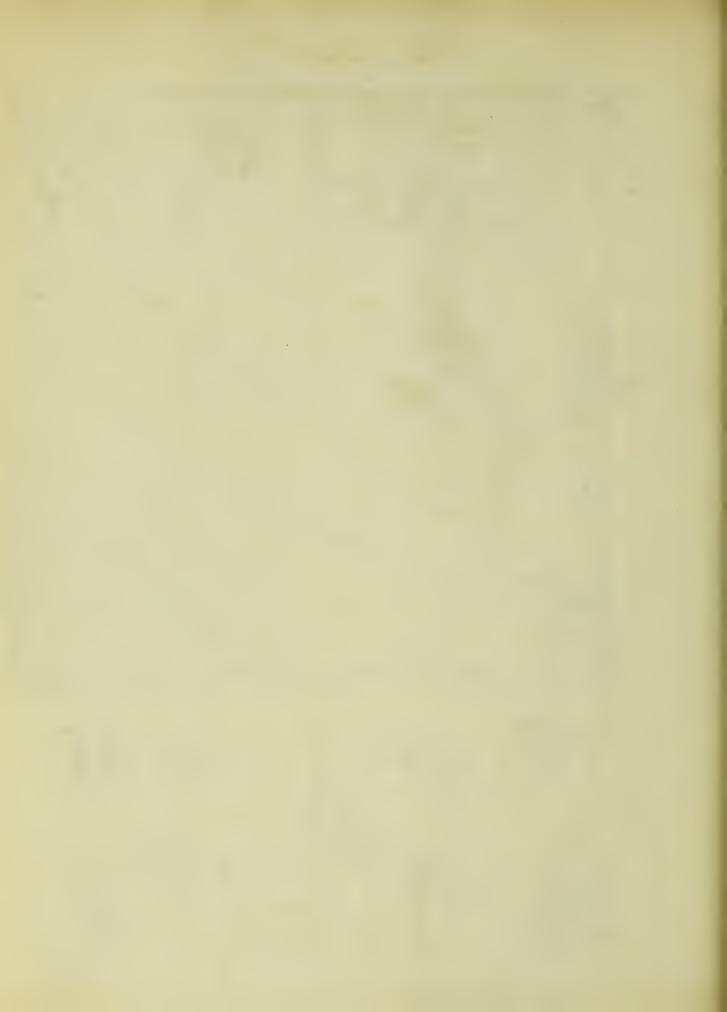
An average card was taken and transferred from the P. V. plane to the T. N. plane and the thermodynamic efficiency found to be 34 per cent.

Enough data was not taken to determine the potential efficiency.







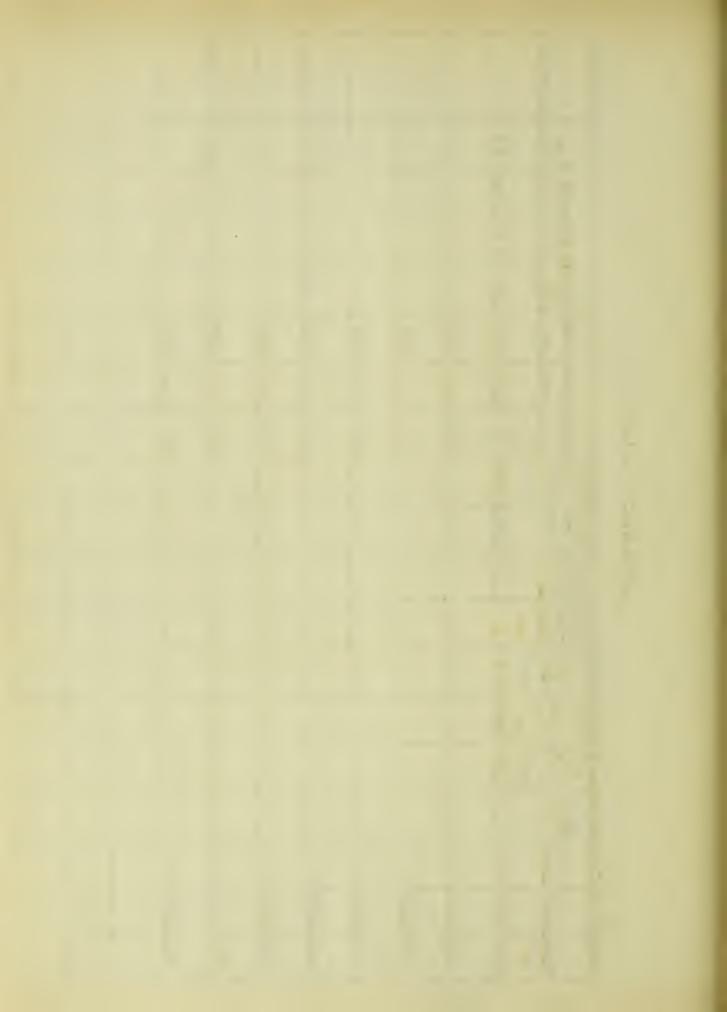


CALCULATIONS FOR TRANSLATING INDICATOR DIAGRAMS INTO TEMPERATURE—ENTROPY DIAGRAMS.

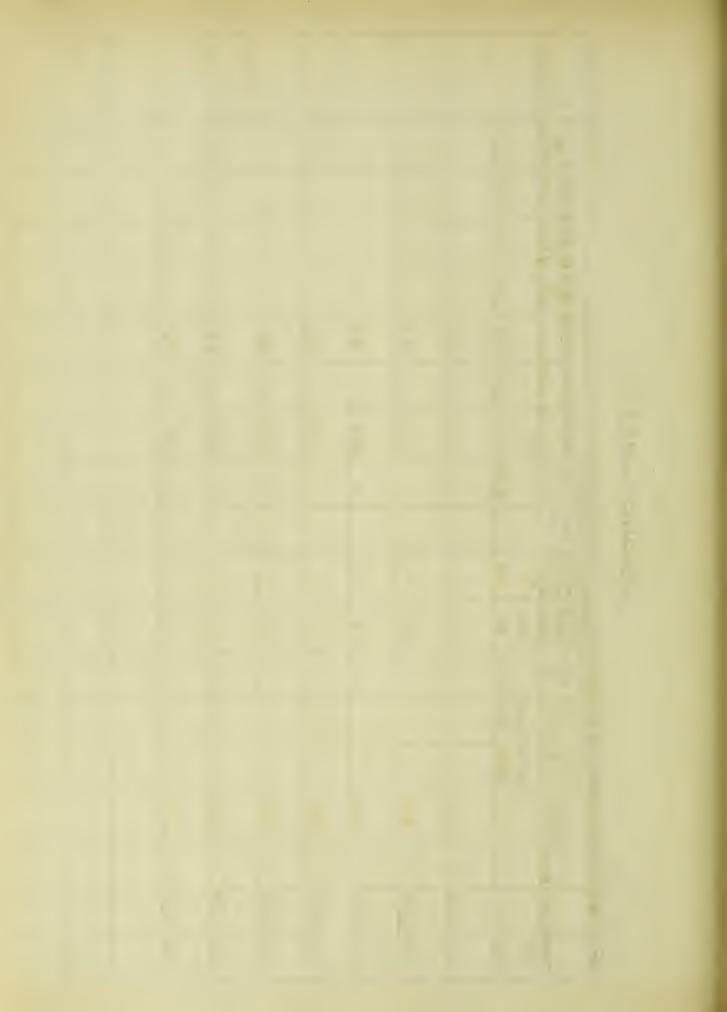
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2,	1.048	1.3-	3. 3-	,021	,176	,740	860	3140	,065	,3/3
3,	1.08	1.3-	6.3	,033	,176	,813	835	3600	,05-6	,336
4.	1.12	1. 5-	7	,049	.176	,845	805	3740	,047	,342
5,	1.16	1.5-	7	,064	176	,845	776-	3620	,038	,332
6.	1.2	1.5	7.5	,079	,176	,875	750	3700	,028	,336
7,	1.248	1.5	8	,097	,176	,903	720	3840	,017	,338
8,	1.297	1.5-	8.3-	,///	,176	,929	695	3940	,009	,34
9,	1.35	1.5-	8.75	,/.30	,176	,942	665	3880	-,003	,334
10	1.4	1.3-	9	,1.46	.176	,95-4	640	3840	-,013	,328
11.	1.472	1.5	9.5-	.167	,176	978	6/3-	3880	-,026	,326
12.	1,543	1.75	10	,188	,243	1,00	680	3880	-,009	.324
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15	1,8	2.3-	/3	,255	.398	1.114	835-	4320	,017	,332
16	1.91	2.9	/3.5-	,281	,462	1.130	910	4240	,029	,322
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18	2.16	3, 3-	17	,334	,5-44	1,230	970	4700	,032	,324
19	2,32	3,75	17.5	,365	,574	1,243	965	45-5-0	,026	,320
20	2.49	4	20	,396	500,	1.301	960	4840	,099	,326
21	2.7	4.5-	23	431	,65-3	1.362	1000	5100	,019	,332
22	2.94	5-	22.3	468	.699	1.35-2	1020	4560	,017	,306
23	3.24	5:5-	30	,5-11	,740	1,477	1035	5550	,009	,333
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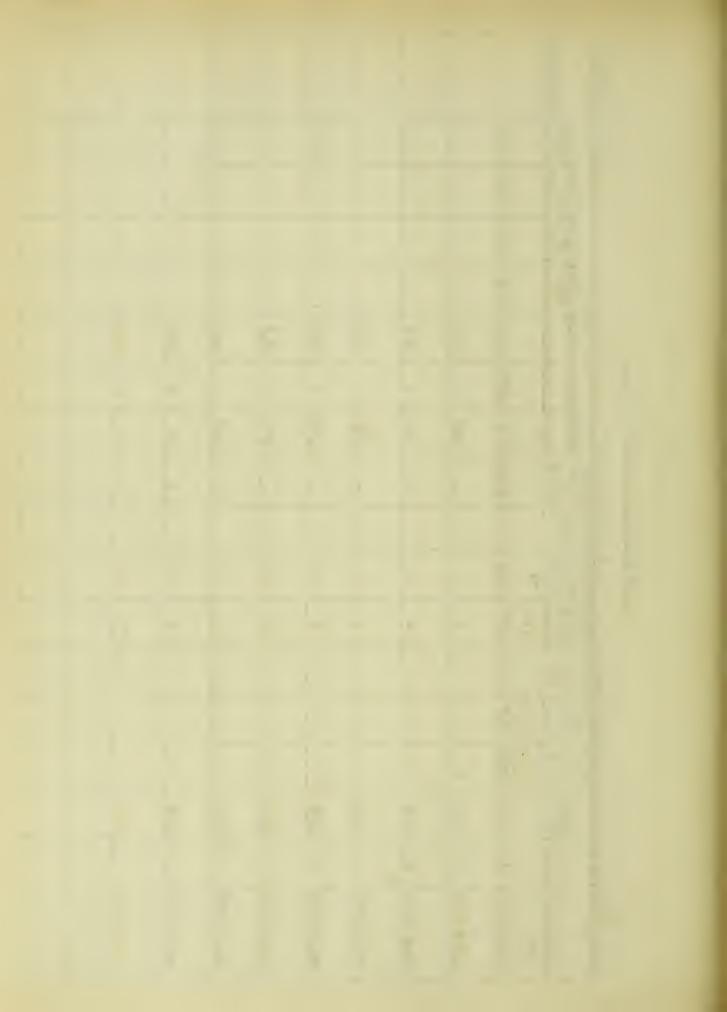
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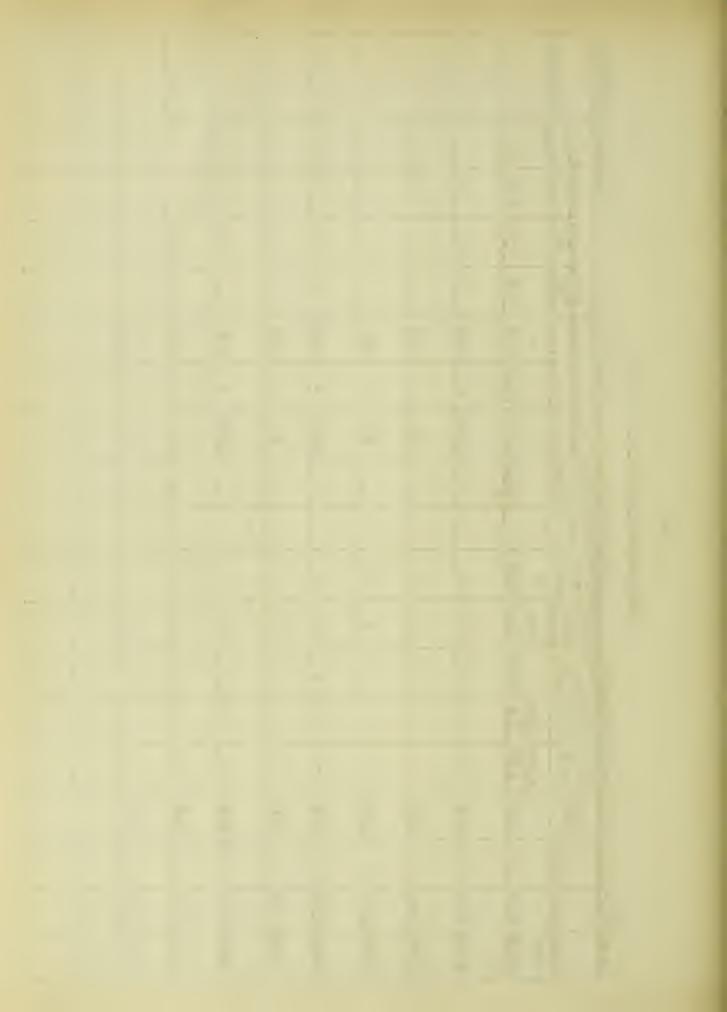
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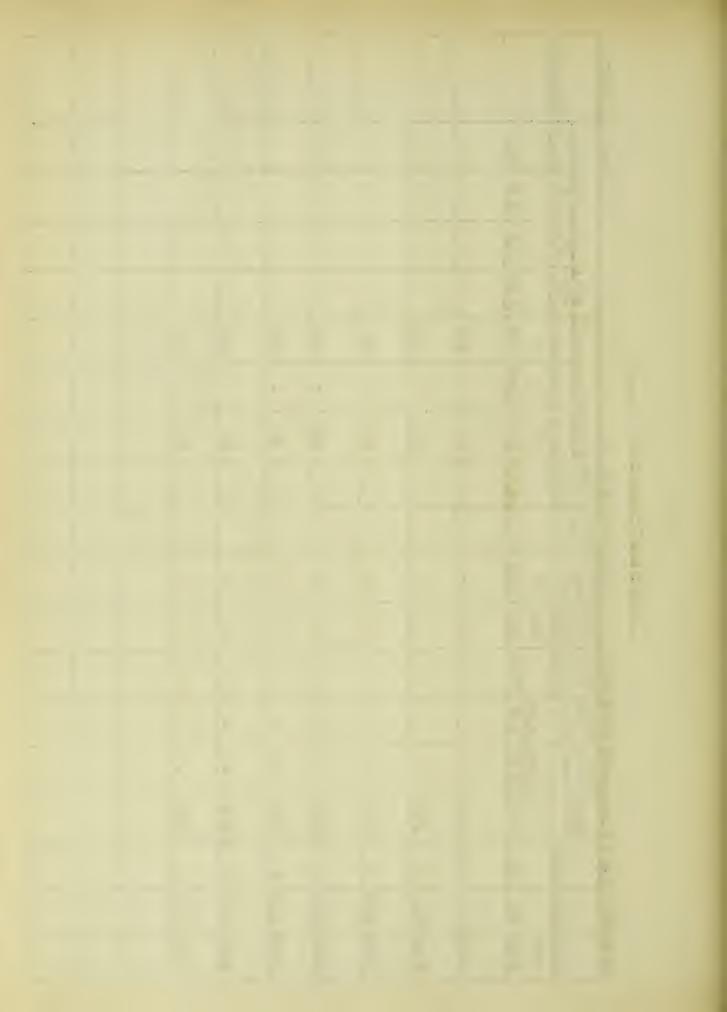
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4504	BH.P.	.26	25	50	294	8, 4	29	१३	eri 4	,24 4		
IOHR OTTO GRSOL	B.H.P.		3	:	:	:		۲		ŧ		
POT	E J.H.P.	3,82	2:54 3.96	<i>y</i>	5. 4.	4,12	e 346	42	4/4	9.14	-,	
707	TIME	F.M. 2:52	2:5	256	858	3.00	3.08	304	306	3:08		

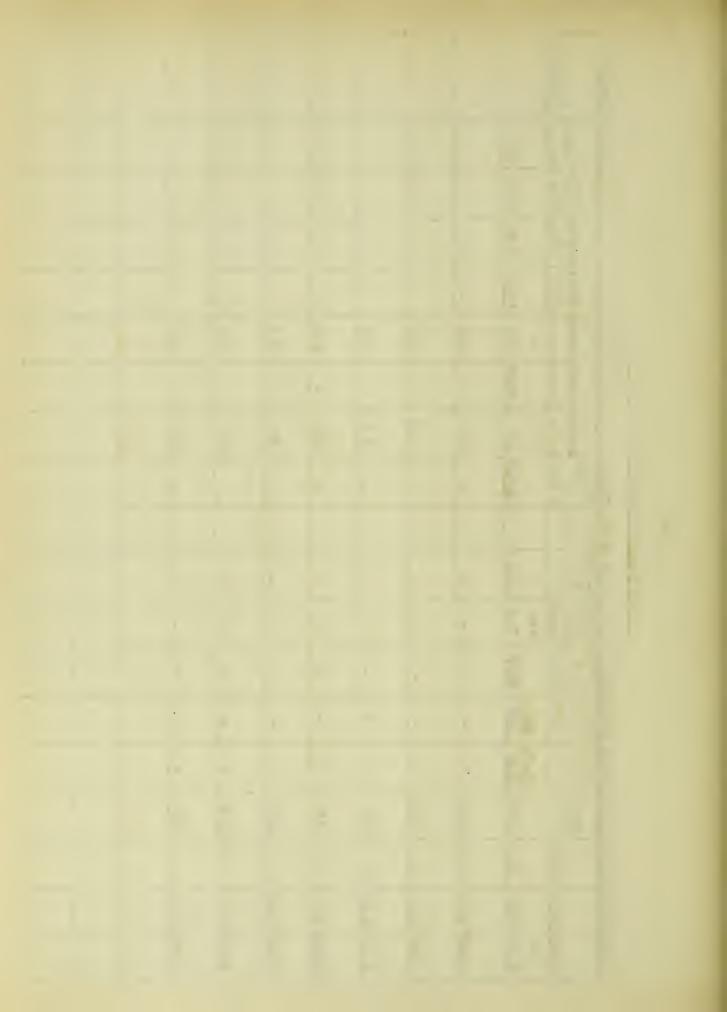


HPVI 11, 1905		REMARKS											
Pril	G.E.	RAD.		13.3	:	:	•	;	;	:	:		
ħ	4	EXH.		3.7	٤	•	;	:	;	:	:		
		THOTET		લ	:	ε	;	:	:	:	;		
	BT.U.	WORK		2.8			÷	;	ų	:	:		
	B.T.V. PER DRIB FROM CARDS	MEE	#	83	66	83	68	2/6	88	68	96	 -	
	FROM	LENGT	*	2.45	÷	ŧ	"	"	"	"	"		
1	ряти	BREA	""	.85	1.01	38.	16.	84	6.	16:	86		
TES	187.0. PER.	643		19130	, , ,	"	*	"	٤	*	*		
4.67	POT. EFF												
6	THER MO.		1%	34	*	:	r	2	:	:	ž		
	4		cts.	5,6	:	:	·	ŧ	:	:	ı		
INE	RHT10 BIR TO	GHS		75.7	:	:	"	"	"	,,	"		
FNG	G.H.S PER	14/11/	Ca.Fr.	.28	:	:	,,	2	:	:	:		
INE	AIR PER MIN		CW.Fr.	205	:	*	"		•	2	"		
H.P. OTTOGRSOLINE	BH.P			43	36	45	43	,50	14.	42	,39		
TOG		BHP		હ	÷	n	"	"	"	"	"		
POT		IMP		4.6	5.5	4,4	238 4.65	240 398	4.9	4.8	5.17	-	
101		TIME	P.M.	132	234	236	238	240	84 84	2:44	2:46		

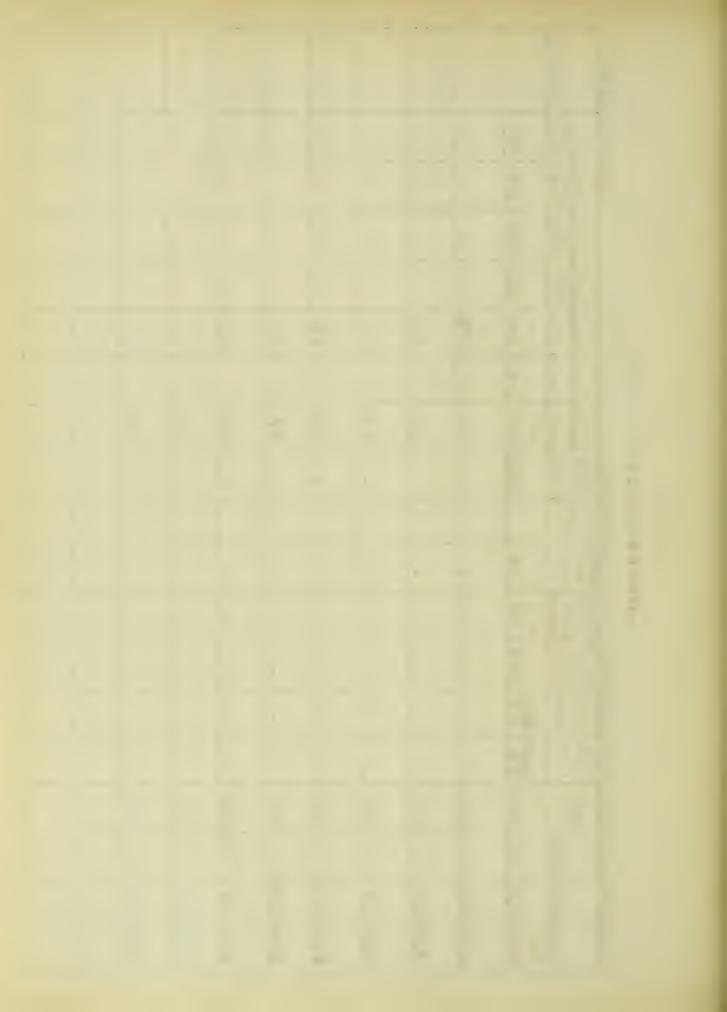


18. RESILTSHEET

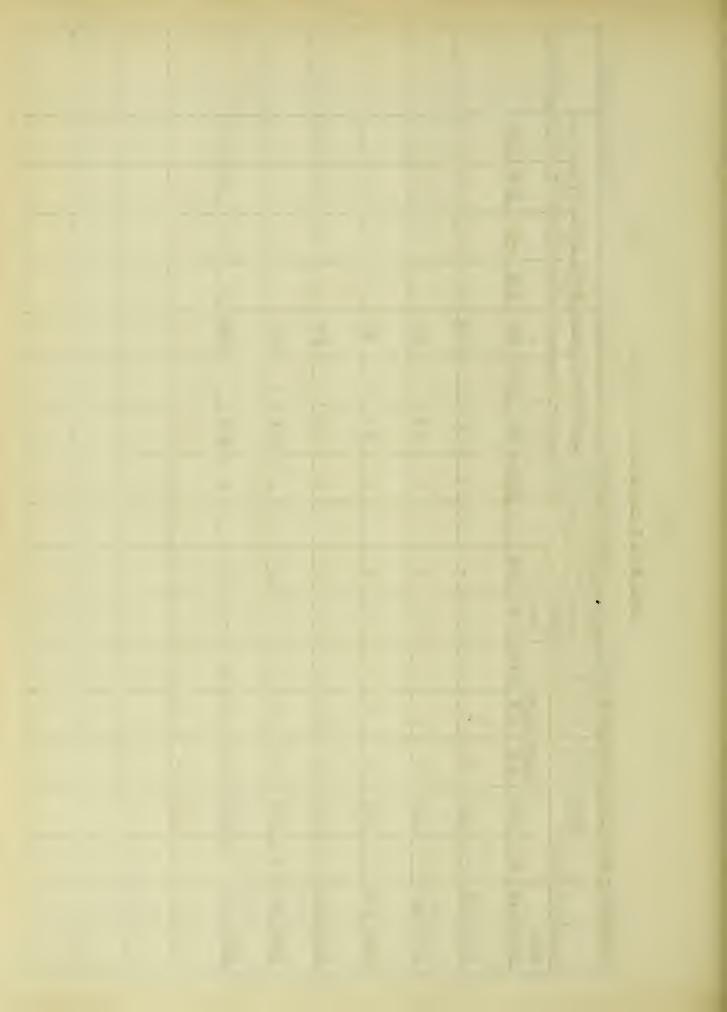
.3067		REMARKS											
April 17, 1905		A CHB		3,1	•	٠		:	Ł	;	:		
P	ANGE	EXH.		200	•	:	:	•	t	"	4		
	I-BB1	SH CKE		5.9		:	:	:		"	"		
	B.7.1	ע ≥		3./	:	:	÷	:	:	٤	z		
	DATA FROM CHRUS	MER		100	88	103	95	601	93	86	73		
	FROM	LENGTH	"	245	t	*	:	•		*	:		
	DHTH	MAEA	""	777	90	1.05	76	///	95	46.	.75		
Test.	B.T. U.	1		113203 111	2	ŧ	:	ε	×	2	:		
H.P.	ZPOT.												
લ્ય	THEH MO.	EFF	1%	34	t	:		2	2	٤	:		
	PER	BH.P. HOUR	cts	7.4	Ł	•	*	z	·	2	:		
INE	ABTIO BIR			1:09	:	•	:	٤	ï	"	z		
ENG	GAS. PER	MIN	CuFt	100	:	ŧ	٤	ŧ	ž.	٤	:		
1100	AIR PER	MIN.	Cu.Fr.		:	:	٤	"	,	t	:		
OH.POTTOGASOLINE	BHE	I.H.P.		.415	507	435	747	141	.56	.54	49		
TOG		B.H.P.	(ગ		"	*	"	"	*	:		
POT		THE	. (4.8	3.94	4.6		4.9	3,64		4.1		
H01		TIME	P.M.	230	35:32 32:33	2:34	2:36	2:38	240	2.42	2:44		



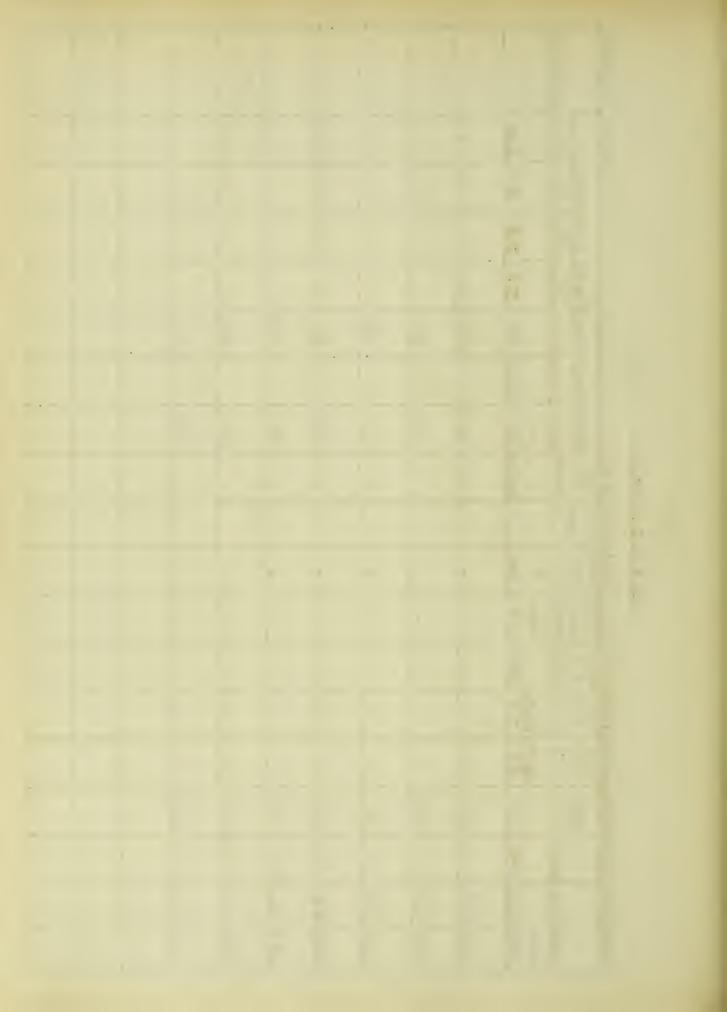
		T	T									
1905.	SHAHWAA											
April 17,1905.	F, N PAD	8.8	:		"	**	٤	:	:	:		
HP	E L	2.1	:	"		44	"	"	• •			
	L B H L	8.4	:	:	:	"		٠	:	:		
	B.T. B.T. W. W. W. M.		;		ε	÷	ţ	:	z	:		
	BREPLENGTAMER			114	9//	96	94	90	93	86		
	FROM	2.45		ž.	:	"	"	· ·	"	:		
				1.16	1.18	86.	96.	98	.95	88		
Test.	BT.U. PER. 7 H S.	18263	"		и,	"	u	"	11	u		
HP	POT. EFF											
3	MER- MO- EFF	34	Ł	2	ı	>	*	u	•	:		
	COST PER B.H.P. HOUR	cts. 3.6	и	z	2	٤	ž	:	:			
INE.	PHTIO A,R TO	1:96	"	<i>t</i>	2	·	*	ε	٤	2		
ENG	GHS PER MIN.	04.F.	u	z	u	:	7	٤	ž.	i l		
INE	AIR PER MIN.	Cu.F.	*	٤	=	ì.	١	:	٤	٤		
1051	BH.P.	95,	445	455	46	49	50	52	15	565		
OTTO GASOL	B.H.F	Ŋ	ž	:	E	٤	٤	•	*	"		
POTI	TIMETHE	7.7	6.75	6,6	6.7	1.01	5.97	5.7	5.9	5.3	×	
IOHE	TIME	P.M. 2:05	2:07	2:09	2:11	2:13	2:15	8:17	2:19	१३:३।		



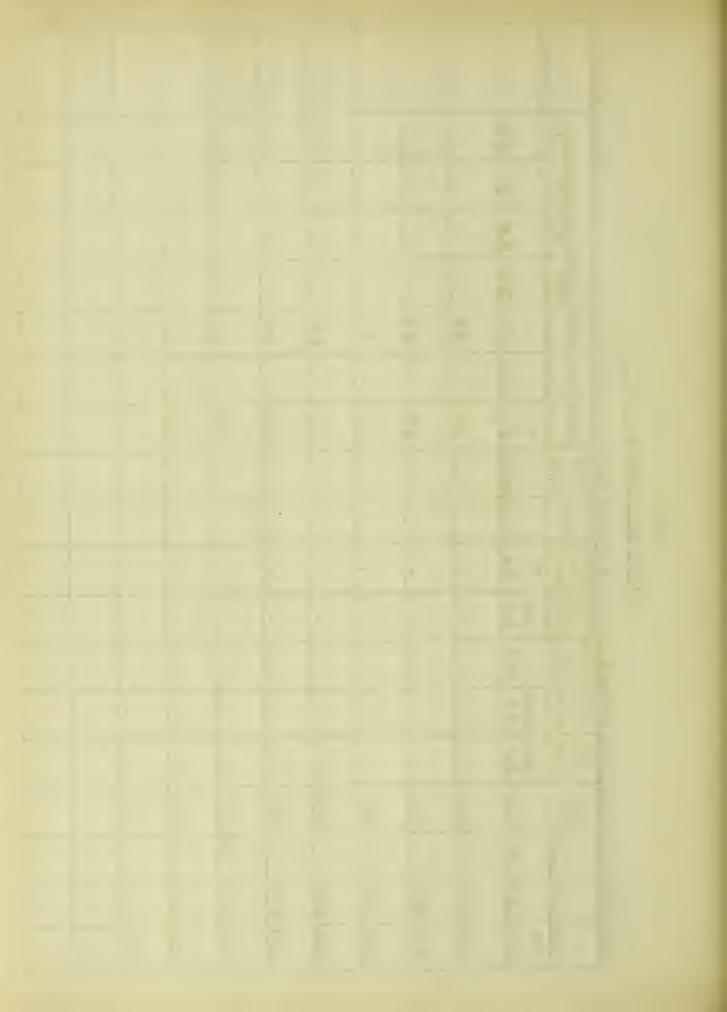
11,1905.	PENHRKS									
. 1	," RHD	7.9	;	:	**	•		:		
April	CA CHIENCE	2.4	:	1	,,	Ł		"		
			٤	•	"	H	**	"		
	B.T. I B.T.U. NORH	3,2	:	:	:	ü	:			
	OPPIDS.	#	86	73	16	66	98	866		
	BREHLENGTH MER	2.45	u	"	u u	· ·	"	"		
	DRIBE AREH.	95	,	.75	.93	1.14	88.	811		
Test	BTU. PER. GHS.	19130	, "	"	"	"	"	"		
H.P.	POT. EFF									
2	THER MO. EFF.	34		£	4	μ	ŧ			
	PER PER B.H.P.	c73.	"	"	u	t	,,	"		
INE	AHT PIN TO G B	79:1	"	:	"	ů	"	"		
ENG	GAS PER MIN.	Cu.Fr.		*			~	2		
INF	AIR PER MIN	CU.F.		"	"	"	,,	ž		,
1052	B.H.P. I.H.P.	495	485	64	,55	.54	.57	.52		
10 H.P. OTTOGA SOI	B#.P	B		:	,,		2	"		
POT	Z.H.P	6.05	6,2		5.4		5.25	8.5		
10 11	TIME	P.M. 2:09	\\\:&	2:/3	2:15	2:17	2.19	18:81		



17,1905	AEMHRKS											
Hpril	1.N RHD A		:	:	;	:	:	:	ε			
P	HNCE ''' EXH.	,57		:	:	:	:	:	:			
	BBL 672 JACHEL	4.7		:	:	:	:	:				
	B.T.U 87.V. WORN	3.4		:	•	·	•		"			
	MEP		801	75	86	88	801	84	06			
	TOM GA	2.45	"	"	"	"	"	"	"			
	BRIBEROM CH	a" /	/:/	24	/	06.	1:1	98.	36.			
PST.	BT.U. PER # GHS.	19263	"	,,	"	,,,		4	ų			
P. 7.	POT. EFF.											
4 H	THERMO OYNAMI EFF.	34	•	"	4	b	h	"	ŧ			:
	COST PER B.H.F. HOUR	cts. 2.7		u	4	u	u	u	"			
	99710. 418 70 78 H S.	1:96	••		"	n	"	"	"			
		Cu.F.	"	4,	u	n	"	"	•			
NEEN	AIR PER MIN.	Cu.Ft. Cu.Ft.	**	er	"	"	**	**	"			
1705	B.H. P. I.H. P.	09.	.54	999	.51	09.	.50	49.	625	•		
10 H.P. OTTO GASOLINEENGINE	BHR		"	"	"	"	"	,,	***			
P OT	TIMETHE	6.65	7.4	9	7.85	6.6		6.25	6.4		,	
101	1 M	F.M. 130	(3E)	1.34	1:36	138	1.40	148	1:44			

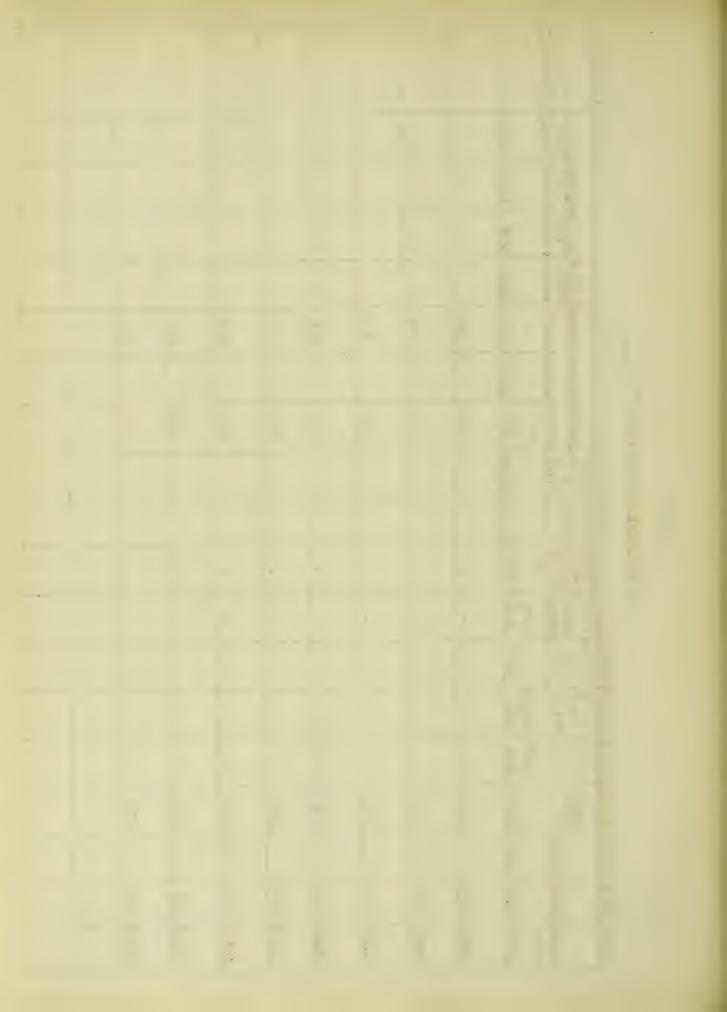


11.1905.		REMBRKS										
HPril		AND.		6.5	2	t	:	,	"			
	HNGE.	IN EXH.		5	ţ		:	:	.,			
	BAL	7		2.4		**			"			
	B.T.U.	B,TO.		3./	t	"	"	ì	5			
	DATA FROM CARDS	LENGTH M.E.P.	#	78	86	89	86	86	74			
	FROM	HENGTH	"	245	ų	"	"	ž				
7	DATA		.0	08.	/	20	/	,	32.			
res.	B.T.U.			19130.80		· ·	ü	:	:			
H. P. 1	P. POT.	EFF										
4	THER-		1%	34	,	,	£	:	2			
	COST	HOUR	ots.	3.3	:	٤	٤	2	,			
YE	RATTO.	GHS.	.49	64.1	*		2	:	:			
ENGINE	GAS		CUF	21 33	۵	"	:	:	:			
		WIW.			=	2	e	:	t			
H501		Z.H.P.		09.	475	69.	49	49	.65			
10 H.P. OT TOGASOLINE		BALE	•	4	:	,,	٤	į	=			
1.P. 07		EIHE		16.65	8.4	5.78	8.1				`	
101		TIME	F.W.	1:44	1.46	1.48	1:50	152	1:54			

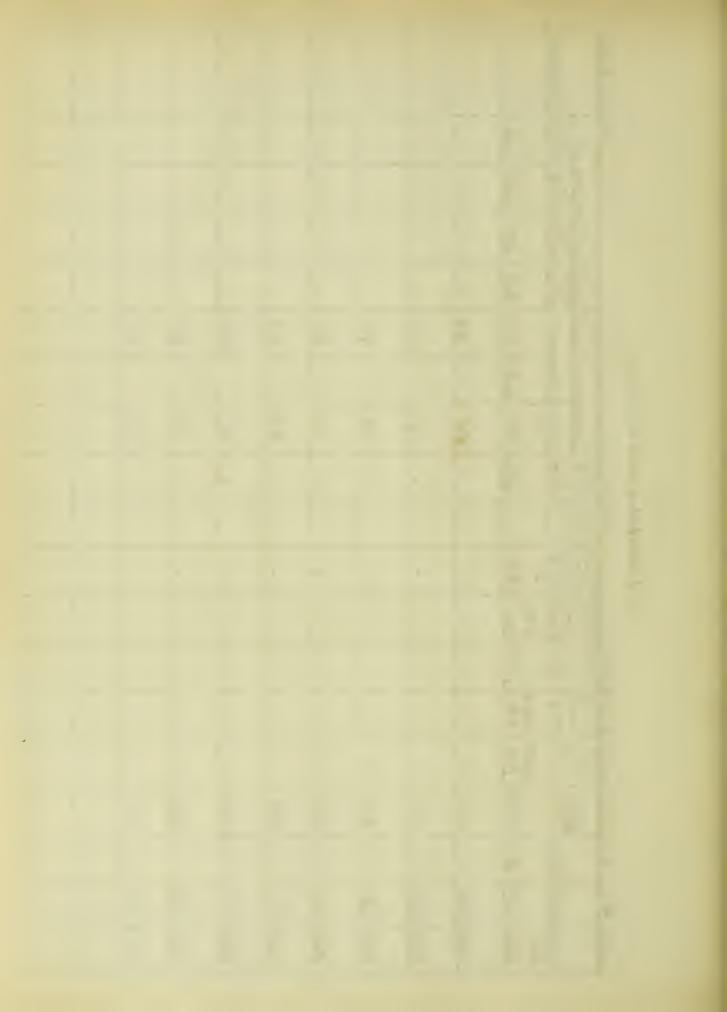


83.

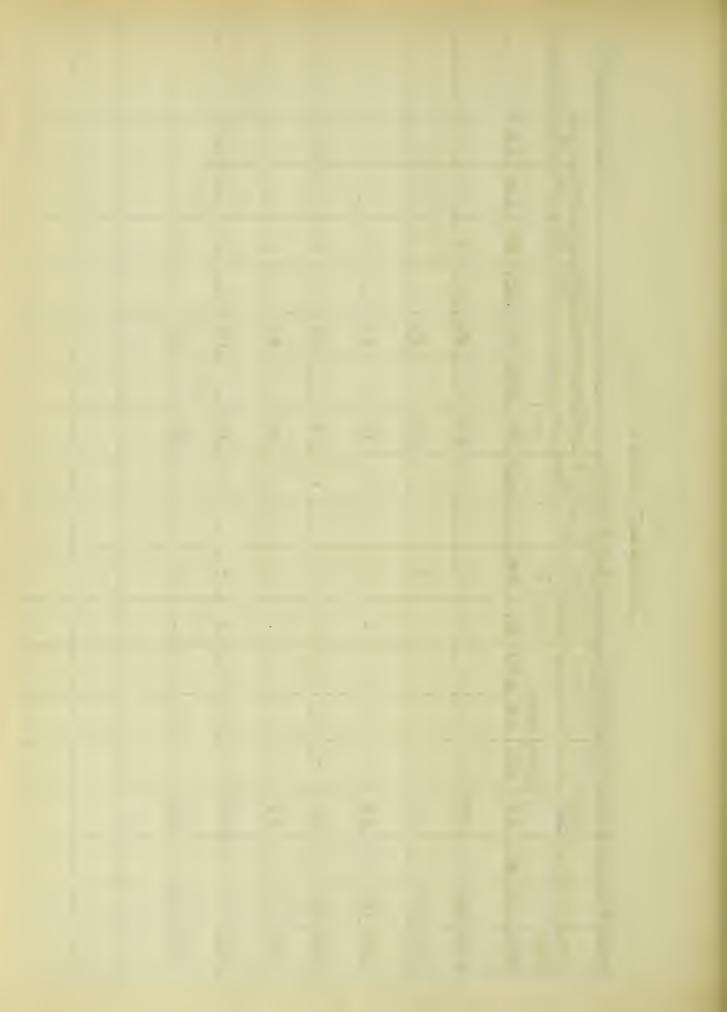
April 6,1905.	REMARKS											
Tpril	CE. AMD.	4.75	:	;	:	:	:		z	t		
F	1, BU	27	"	**	**		.,	",	•	:		
	4. B. F. B. F. C. F.	7.8	,,	•		,	:	*	ı	:		
	B.T. BF.U. WORK	315	,,	:	"	u	£		u	:		
	HADS			48	66	86	94	95	100	86		
	PREFICENCY CARDS	, of	"	*	"	u	"	"	,,	,	:	
	DRIBE	.84	48	68.	101	1.00	96	26	1.02	,		
Test	B.T.U. PER # G.H.S.	19.130	,,	h	u	"	n	ν	1,	"		
H. F	POT. EFF.											
	THER- MO- EFF	34		:	b.	•	:	n	t	:		
	GASMATIO COSTA PER AIR PER Y MIN. G. HOUR	cts.	:	٤	ı		ž.	ż	ų.	t		
INE	RHT/C R/R TO G.	1:11	"	,,		,,	٤	"	u.	ŧ		
ENG	HIR GAS PER PER MIN. MIN.	CuF+ CuF+.	,	<i>n</i>	ŧ	*	÷	4	"	2		
INE	HIR PER MIN.	CuFt. 22	u.	ų	"	,,	**	ü	:	:		
OHEOTTOGASOLINE	BHP. I.H.P.	535	544	516	47	493	51	.51	.476	47		
706	B.H.P	5	ţ	"	× ×	"	"	ž	٤	*		
POT	TIMETHE	P.M. 3:44 9.35	9.2	9.7	10.8	10.4	8.6	8.6	358 108.	10.	,	
101	TIME	P.M. 3:44	3:46	3.48	350	3:52	3:54	3:56	3:58	4:00		



April 6,1905													
Peril		1	-										
A	'CE'		00	:	:	:	:	ţ	,	:	:		
	VHTE		144	:	:	:	:		;	,	:		
	NETH BHILLIN	1	8:1	:	ı.	··	ï	"	u .	:	٠		
	Q :	0	3.2	t	"	"	"		"	i,	1		
	CARDS	# # 6	7,6	88	46	98	86	56	46	56	16		
	FROM	, (245	"	*		"	"	*	"	ı.		
est.	DHTH FRIMCHRDS	# " " " " " " " " " " " " " " " " " " "	7,7	06'	2%	94	′	97	96	46.	.93		
P. Te	BITU PER		19130	;	ŧ	ı.	:	:	ŧ	,			
5 H.J	POT- ENTIRE EFF		1										
	THER MO-DY NAMIC	12	34	•	;		:	,	4	:	:		
li)	COST PER BH.P.	c ts	9.72	2		Ł	ı	Ľ	:	٤	;		
GINI	PH710		1:19	:		٤	'n	۵	٤	٤	"		
EEN	GHS PER NIN	CuF	53		ť	٤	:	ŧ	:	:	ž		
MIT	MIN. MIN.	Cu.Ft.	202	,,	"	:	:	t	÷	ì	"		
GH S	EM P	1	4.10	55	51	53	47	.51	53	515	55		
770	THE GHS RHTO	L	3		. "	:	"		:	:	:		
F 07	2		16.3	21.5	28.5	9.5	10	8.6	9.5	9.7	9.15	-	
10 H.P	, , , , , , , , , , , , , , , , , , ,	P. 1.	3%	321915	3,23 9,85	3,8 2,85	3.27	8% 632	33/	3:33	3.35 9.15		

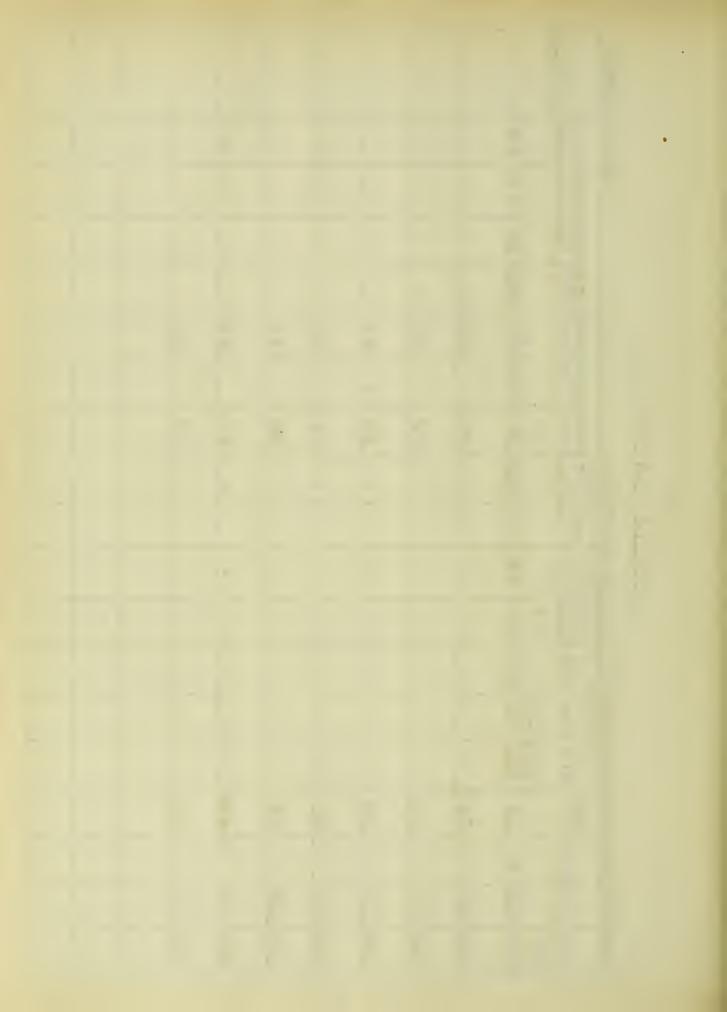


13	2										
1905	HEMHRKS										
9	AEA										
pril	A'N A'ND.	4/			:	***	×	"			
H	HNCE EXH.	k)		4	:	·	••	"			
	BAL GYL:	M.	:	:	:	:	***	<i>"</i>	:		
	BTU.		٤	ę	u u	"	"	÷	÷		
	FROM CHRUS	# 68	1	98	88	83	88	84	84	-	
			į	"	"	"	"	×	k		
	. 4			88.	90	.85	06	98.	98		
est.	B.T.U. PER # 6 H S.	05/0/	-	ı.	٠	h	"	u	,,		
L.P. 1	POTEFF										
19	THER MO. EFF.	% W	=		•	t		·	:		
	RHTIOCOST I RIR PER TO B.H.P. GRS. HOUR	ots 9,1	:	:	£.	"	"	ž	٤		
LE.	RATIO AIR TO GHS.	1:67	:	u	44		"	:	:		
NGIN	GHS PER MIN.	Cu.Ft. CuFt	1		"	ı	"	z	÷		
INFE	HIR PER MIN.	1		ı	u	:	•	ė	ŧ		
1	BH.P.	594	.594	594	00	604	.59	.594	605		
IOH.P. OTTO GASO	OH W		=	u	"	ï	٤	٤	ŧ		
2077	THP		1 `	1	0/	8.6	3.05/0.5	101	9.85		
10 H.F	TIME	P.M.	2:57	2:59	3:01	3:03	3.05	3:07	3:09		

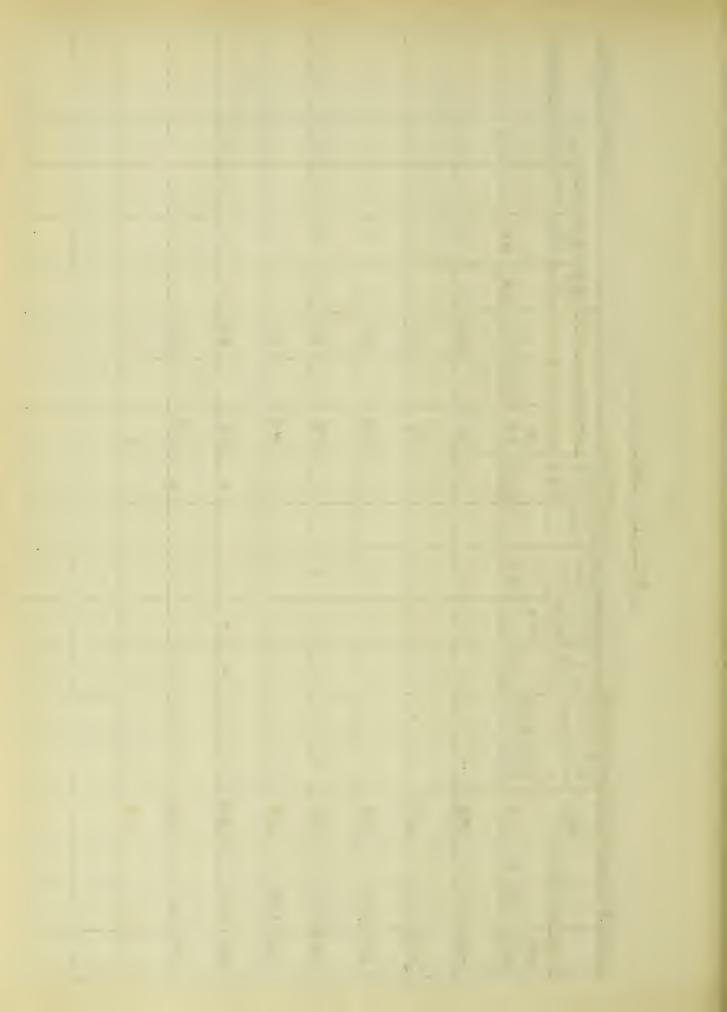


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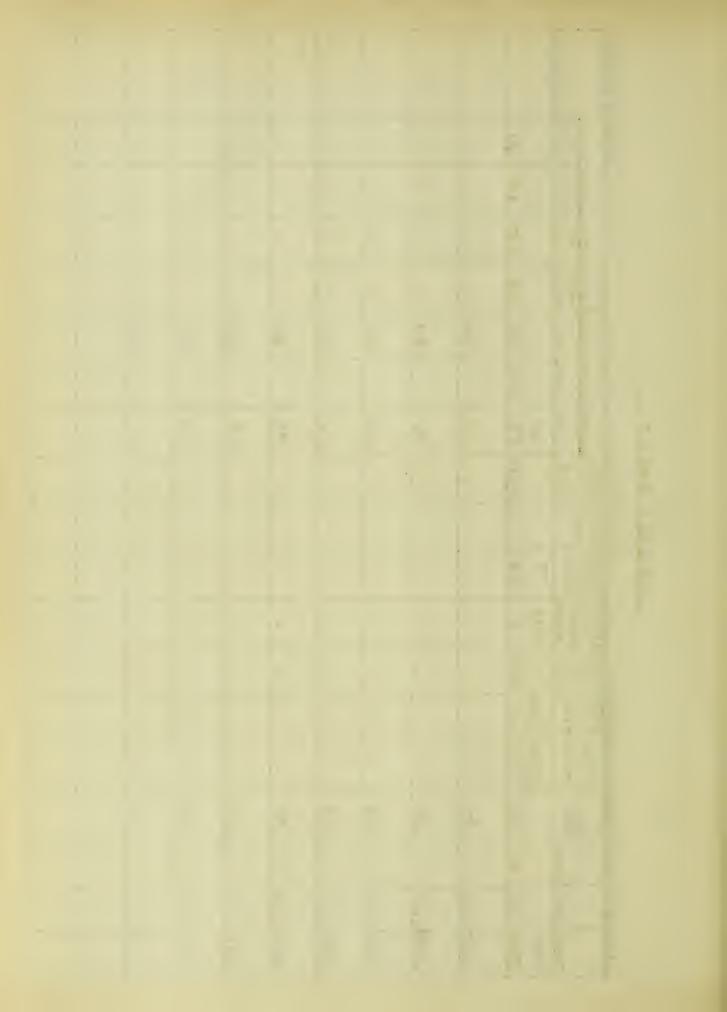
April 6,1905	PEMHRE	1									
pril	E. A'A D	88.		:	•	2	÷	ä	:		
h	EXH.	65	:		ť	:	:		:		
	I. B. B. Inche			÷	٠	ę	:	:	:		
	B.T. (B.T. () WORK		"		٤		"		u		
	CHROS		88	28	88	69	06	68	88		
	ORTHEROM PREB LENER	2.45	"	u	"	"	,,	**	"		
		90	90	.84	96	99.	92	16	96.		
est	BTU. PER. GAS.	19.130		"	t,	•	"	и	u		
PI	POT EFF										
H 9	THER- MO. EFF.	34	ε	ŧ	,		ų.	4	,		
	COST PER BH.P. HOUR	cts. 2.4	u		٤	"	ı	ε	2		
Ē	RATIO NIR GBS.	62:1	:	:	ŧ	'n	"	ž	ε		
NGIN	GAS. PER MIN.	Cu.Ft.	,,	"	t	"	"	"	"		
NEE	PIR PER MIN	Cu.Fr. Cu.Fr. 22 .35	"	"	*	u	<i>"</i>	"	ž		
H5041	BH.P.	.56	555	509.	59	80	95"	566	566		
	BH.P	9	n	"	٤	"	"	,,	u		
OHPOTTOG	I.H.P.	10.7	108				10.7		106	`	
10 H.F	TIME	P.M. 230	21.32	2:34	236	2,38	2:40	242	2:44		



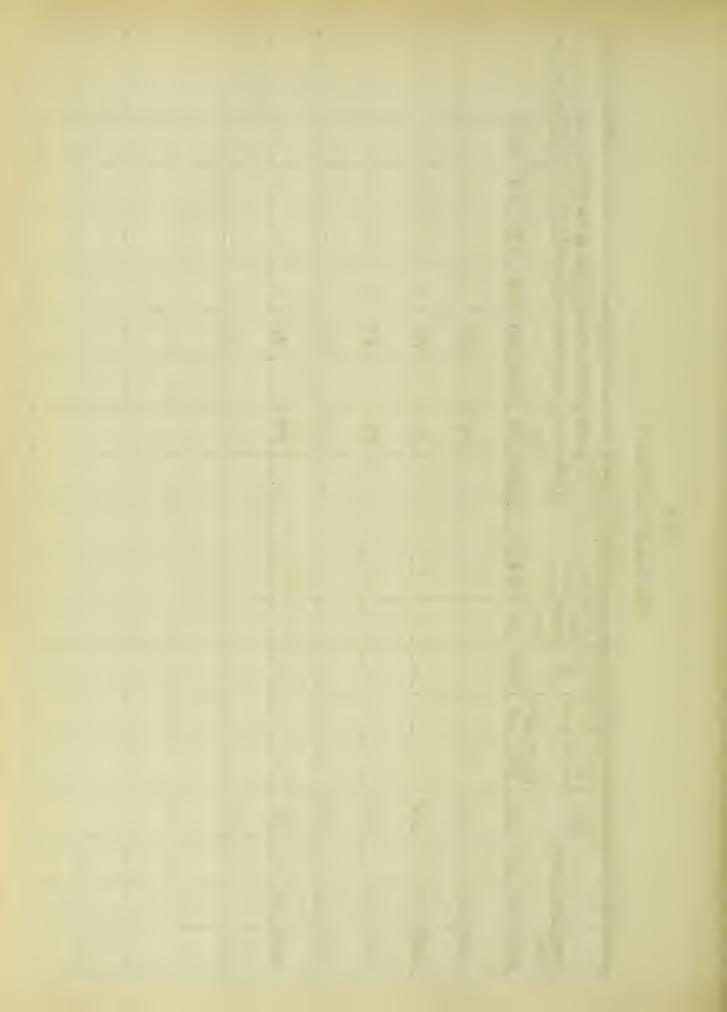
Hpril 5, 1905.		HEIGHMUS												
pril	", UDB			2.4		:	;	:	ŧ	:	:	:		
H	BNCE EXH.			1			:	:		¢		:		
	CKL.	JHCKE		41			:	:	:	:	;	:		
		MERWOHK		3.4		:	;	:	:	÷	:	:		
	RRDS	MEP	#4.	89	776	7,1	88	16	48	87	08	85		
	BOMC	LENGTH	•	2.45	:		,,	:	÷	:	ž	ŧ		
		4	D,	16:	74	9 /	90	93	9%	68	<i>S</i>	18.		
Test	B.T.U. PER	G#3.		19130	`		*	u	:	:	z	2		
H.F.	POT, EFF													
	THER- MO. EFF	1	?	34			:	:	:		:	:		
	COST PER B.H.P HOUR		ots.	198		:	:		·	·	:	٤		
	RHTIO PIR TOS. GHS.			1:09	:		:	:	:	:	:	:		
GINE	GAS. PER MIN		Cu.Ft.	.34	:		4	*	:	:	:	:		
VEED	A/B PER MIN.		Cu.Ft Cu.Ft.	204			:		·	:	;			
2011	THP.			19.	06	0)	625	19	59	49	999	20		
-0 GB		BHE		7			t	· ·	`	:	;	:		
OHFOTTO GRSOLINE ENGINE		THE		11.4	0		21:1/		'	601		١ ١	`	
10 H.1		TIME	P.M.	343	, ,	375	347	35/	353	7.5.5	3:57	3:49		



				_									
15,1905		REMBRKS											
Apri	7	RHD	·	4.	:	:	:	:	:	;	:	:	
	FNG	EXH		/	:	:	:	:	:	:	:	:	
	BB	, W JRCKET		3.8	:	:	:	:	:	:	· ·	ŧ	
	1.8	BT.V. WORK		3.5	:	÷			;	:	:	ĸ	
	CARDS	MER	#	95	86	94	101	56	95	95	46	86	
	DRTR FROM CARDS	LENGTH	"	2,45	*	"	"	11	"	,,	"	"	
7.	BTB	GH S. BRER	""	97	7	96.	1.02	86.	46	46	66	7	
? Tes	BT.U.	GAS.		19130	11	:	41	ł,	h	٤	2	,,	
7 H. I		E 1.1.											
	THER MO	EFF	2	34	:	:	e	:	3	٠	•	ε	
	COST	BARR	cts.	જ	٤	٤	,	٠	:	•	2	2	
E	ABTIO BIR	GAS.		53:1	:	:	2	:	:	:	:	ž.	
NEIN	GHS	MIN.	CUF	4	:	E	:	:	:	:	ż	t	
NEE	AIR	MIN.	Gu.F.	21.4	:	:	÷	:	ŧ	:	2	٤	
17057	9	T.H.P		59	8.5	59	.56	09.	.59	19.	58	58	
IOHR OTTOGRSOLINE		BHP		7	ŧ	"	ì	11	2	:	٤	u.	
907		IH.P.		11.9	•	3:23 11.9	325/24	3.27 //6	8.//		65		
IOHI		TIME	P.W.	3.79	321	る名が	582	3.27	3,29	331	333	3:35	

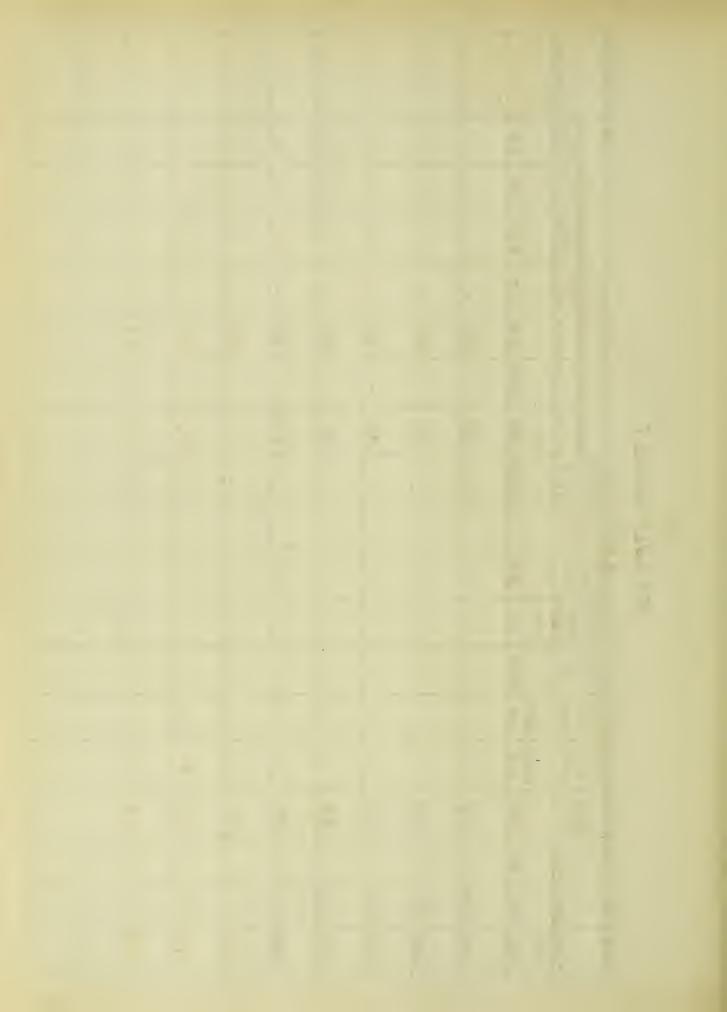


, 1											
115,1905	Na b N a d	4									
April	E. AAD.	7.8	t	ţ	:	:	:	:			
	LANC EXH.	4.	:			:		:			
	CYT.		÷	e		;	÷	:			
	B.T.U.	3.8	:	,		ε	**	:			
				84	48	.86.	91	85		-	
	BATH FROM CARDS	2,45	"	,,	"	"	"	"			
+	HIHO	"0	8	98.	89	88.	.93	48			
Tes	B.T.U. PER #	19/30	:		9	u	"	,,			
H.B	POT. EFF										
8	THER MO EFF.	16 E	,	*	,	:		:	 -		
	HIR COST	0 to	٠		:	ŧ		٤			
	70 H		:	:	:	:	:	:			
FNGINE	GHS. PER. MIN.	Cu.Ft. Cu.Ft.	:	ť	"	<i>"</i>	:	٤			-
INEF	AIR PER MIN.	Cu.Ft. Cu.F.	Ł	"	<i>"</i>	ï	٤	ı			
- 1	BA P. T.H.P.	999	.73	.75	12	75	.72	08.			
OHROTTOGRSOL	4 7	00		ŧ		×	"	"			
POT	7.80	્યું	`		11.3	10.7		01		,	
10 H.	1100	P.M.	7.इ.स	29.90	2:31	233	235	237			



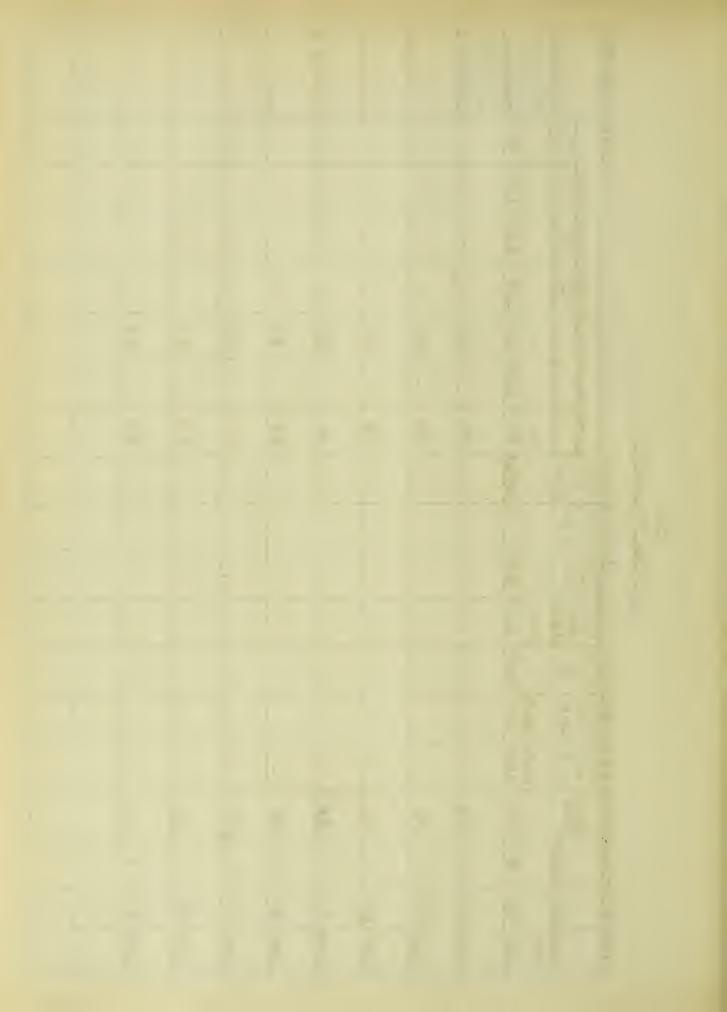
30. RESULT SHEET

5					,							
115,1905		REMARKS										
April	3E	'" RAD	é	:		,,	,,	*				
	LHN	in EXH.	4	: :	:	¢	.,	*				
	1. BHL	ŽĘĆ,	k 1	;	:			3,				
	B.T.	B.T.U.	1	:	:	:	·	•				
	CHRDS	MEP	# 0	93	16	06	92	86				
	OBTH FROM CARDS	LENGTH	: PG		2		*	:				
	DATRI	HREH	""		.93	92	94	94				
FES	B.T.U. PER	₽# S.	0 + 101		=	u	u	h	V			
H.P.	POT.	EFF										
8	THE A MO.		16 k	5		:	\$					
	COST	BHP	075.		÷	:	÷	:				
WE	ABTIC BIR	G. HOUR	14:1	:	:	e	:	÷				
-NGI	GHS	MIN.	CuFF.		:	•	:	٤		 		
INE	HIR PFF	MIN	CUFT.	=	:	2	"	٥				
H501	BHP HIR	7.H.P	0 7	70	00	.73	14.	12.				
H		Y			:		2	ì				
OH.P. OT		EIHE	4 k		14			1/3			`	
104		TIME	P.M.	3.00	3.0%	3:05	3:07	3.09				



31. RESULT SHEET.

5	_												
ril 19, 1905		REMARKS	BH.P. cannot be relied on	ging was not develop ing OH.P.									
April		AAD.	//	:	:	z	:	:	"	:	,		
	ANCE	IN EXH.	7.5	1.	:	2	:	:		14	4		
	BALI		46		,,	:	ï	"		ï	n		
	B.T.W.	B.T.U. INORH	4.7	z	:	u	ų	:	"	:	:		
	CABDS	MER	# 9		88	16	90	92	86	94	80	-	
	DRIR FROM GRRDS	LENGTH MER	245	i i	,	"	"	<i>"</i>	,,,	*	i,		
	DATA	RREH			90	£6'	<i>36</i>	46	7	96	06		
. t s	BTU.	# GH S.	2/661	į	11	"	"	"	11		L		
1PT	POT- ENTIR	EFF											
6	THER MO-	EFF	25 K			ţ		•	,				
	COST	BAREHOUR	0.75.			ž.	b	ï	t	:	٤		
	RATIO FIR	60	43:1	:	i.	"	<i>,</i> ,	"	٤	7	:		
		MIN.	Cu.Ft.	:	2	"	4	:	:	٤	2		
IEEN	AIR	MIN.	CUFF.	:	=	"	*	ž	:	\$	z		
2011	AH P	IHP	46	900	96	1.08	86	66	.95	121	82/		
10 H.P. OTTO GASOLINE ENGINE		BHR	6	•	4	**	"	"	ŧ	ŧ	1		
FOTI		TIMETHE	96		9.4	8.3	9.2	16	9.5			`	
10 H.		TIME	P.M. 1.56	1.58	2:00	202	2:04	206	808	2:10	ર જ		



M 20

RESULT SHEET

Hpril 19,1905	REMBRKS.	The THE Can	not be Used	as the engine	was not de-	Ve loping 3	HPatthis	e e				
87 /	REN	The	not	as th	was	re 10	HPa	time				
Apri	/ N PAD.	6	:	:	:	:	:	•	•	.,		
	U BALANGE 'N' 'N JRKKETEXH.	1.1	:	:	:	2	:	:	t			
	U BALANC IN IN SKKETEXH	4.4	•	:	:	:	:	:	:	•		
	B.T.V. WORK	4.5	:	z	*	:	:	ε	2			
	CARDS	# 88	88	00	90	68	93	16	36	93		
	BRER LENGTA MER	2.45	*	:	:	ž		ţ	"			
7	DRTA		90	90	98.	16.	.95	9 .	46	36		
TES	B.T.U. PE.P. ## Q.H.S.	19263 90	, "		Ξ	Ξ	:	:	2	ŧ		
HEI	POT. EFF											
6	THER- MO. EFF.	34	.	2	2	Σ	•	t	2	ż		
	COST PER BH.P HOWR	675.		ŧ		Ł	*	٤	"	ž.		
INE	##710 #18 70 G .	36:1	:	2	ŧ	:	.	:	÷	"		
ENGINE	,	GuF.	:	2	ï	:	:	•	ı			
LINE	AIR PER MIN	CU.F.	"	*	:	*	•	a.	ŧ	,,		
OH P OTTO GASOLINE	B.H.P I.H.P	90	93	96	.96	796.	18.	97	1.00	1,05		
7700	BHE	9	4	"	ŧ	·	"	"	"	**		
000	TIMETHE	10	4.7	935	935	9.3	9.6	3 9.2	6	P.53	`	
101	TIM	F.M. 2:30	2322	234	237	8:39	2:41	843	245	2.47		



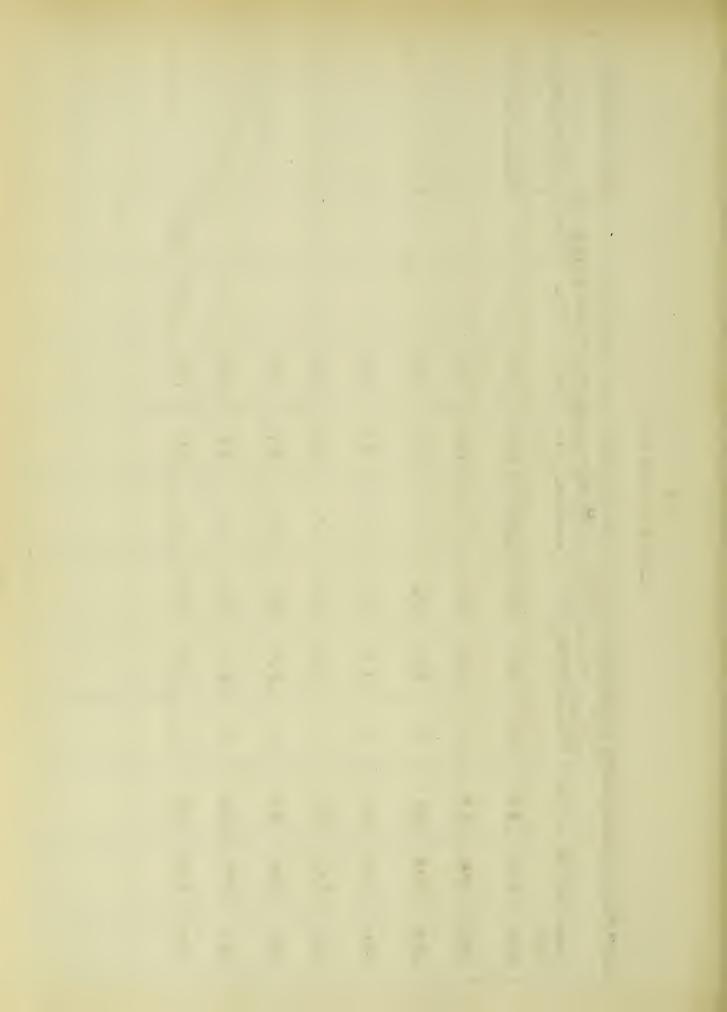
33. DRTH SHEET

April 11, 1905.	REMARKS.	ł	Gasaline=.7									
4	PROM CAL.									¥ 68		
	WT. OF FR CYL.									#41		
	INTER. CHL.	40	95	96	96	46	76	90	88	88		
nTEst	P. OF V.	4.	160	158	091	851	951	251	051	051		
Friction TES		40	64	<i>"</i>	"	ly.	"	<i>i</i> ,	,,	"		
	HIA TEMP. °F		104	98	94	90	88	86	84	82		
N E.	LOHD HIP ON PRESS BRAKE # 6HGE.		10	53	47	40	32	25	81	/2		
FENGI	LORD ON BRAKE SCRIES	*	0	"	"	"	ŋ	•	n	"		
HSOLIN	E.P.M.		24	26	24	24	24	25	25	24		
OHP OTTO CHSOLINE ENGINE	R.P.M.		3//	3/8	310	311	3/8	3//	3/2	3/2		
10 H.F.	TIME	P.M.	322	3,24	3,26	3.2 8	3130	3 3 3 3 3	334	3:36	į	



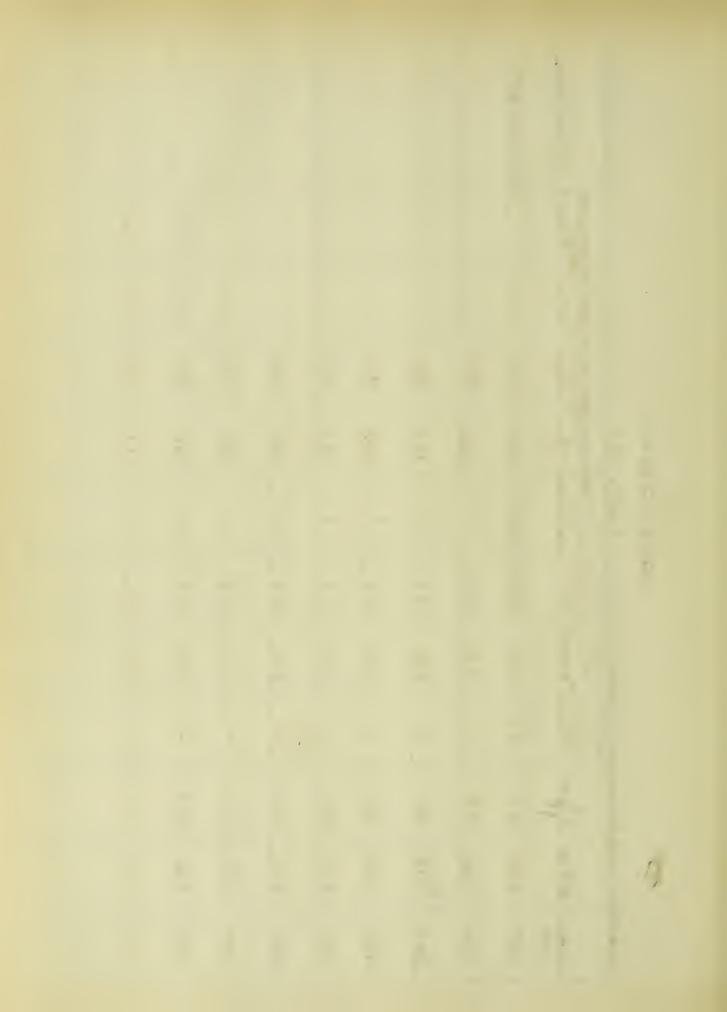
34.

April 17,1905	REMARKS.	Ħ	"2 Gasoline= 1.54									
	WATER TOM. CHL.									_# 62		
	WTOF									*84		
	VATER VING CAL.	40	86	66	100	100	001	001	001	001		
Test.	POFN CYL		102	101	001	66	66	66	66	86		
FrictionTest		G	60 F	u	4	11	e	и	и	"		
	HIA TEMP	•	86	92	98	18	84	94	44	44		
GINE	PHESS *GAGE		70	60	52	44	36	8 द	12	81		
NEEN	LORD ON BRAKE SCALES		0	"	"	"	,,		÷	:		
-0 GASOLI	٠,		6 2	ඉ	88	0 8	68	68	28	<u>૦</u> ૦ લ		
OTTO	P.P.M.		308	309	309	311	307	304	308	309		
10H.P. OTI	TIME	P.M.	3:18	0 ek	ରଧ୍ୟ ବ୍ୟୁ ୨	49.5	୬ ଝ ମ	<i>વ</i> લાજ	3:30	ഷ ഇ ഇ		



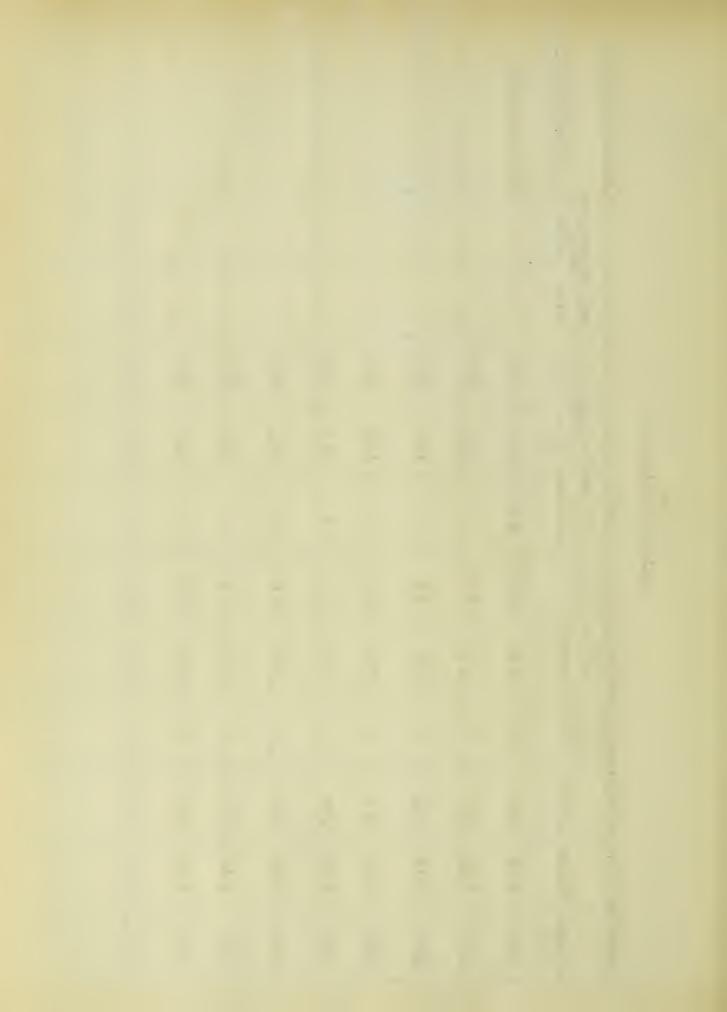
DHTH SHEET.

April 11,1905.	A H H K K K	6									
	WT. OF WHIER.					•			34 #		
	WT. OF FR								18.5#		
	HTER	9/ 9/	16	16	97	46	86	94	93	-	
EST	TEMPOEMATE	16. 16.0	09/	162	162	165	166	891	170		
IH.P.TEST	TEM	# 9 9	,	"	"	"	"	"	"		
	HIA TEMP.	46	92	90	48	48	83	82	80		
INE	PRESS.	09	53	46	39	3/	4%	17	15		
IE ENGINE	N III	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	•	и	"	"	٠	11	"		
ALLOSH	F D M.	47	48	47	86	48	48	51	54		
10 H.P. OTTO GASOLINE	B D M.	, k	3/2	3/8	309	018	3//	3//	3/8	,	
10 H.P.	1 / M F	F:00	30%	3.04	90:2	80:2	3:10	3:12	41:2		



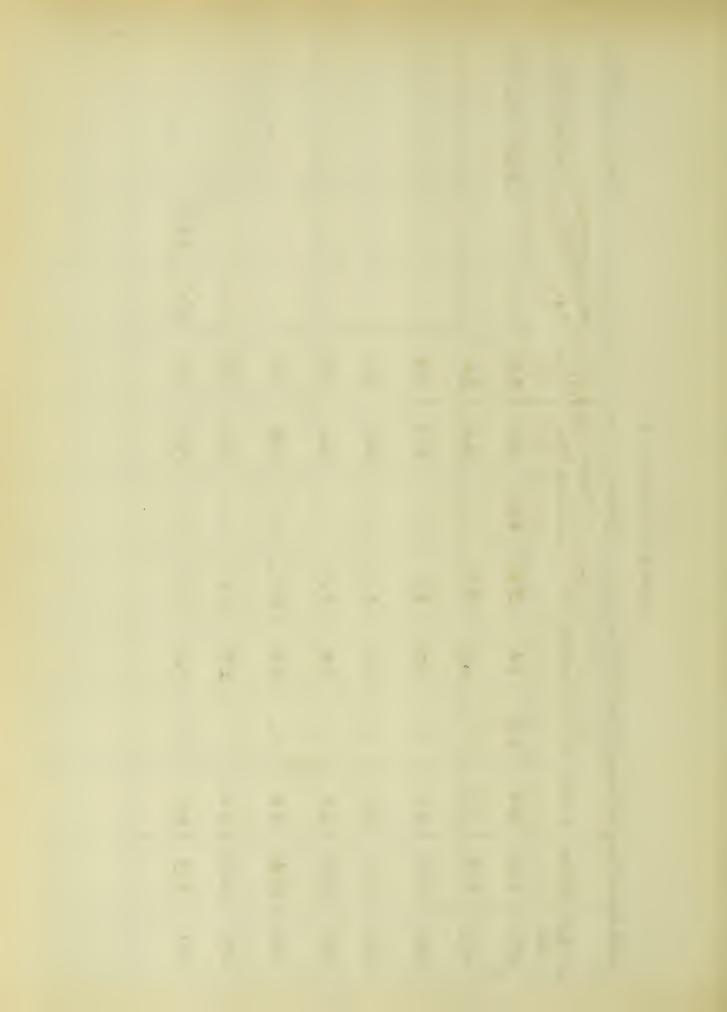
36.

April 17, 1905.	REMARKS	# G' = au; 10 S' B' S										
	WHIER									4 22 *		
	WT. OF				:					75*		
	HTER VING CHL:	7. 96	97	97	98	38	98	38	98	99		
FST.	POEN CYL	0 F	1	115	114	114	113	112	///	111		
IHPI	TE M	7,65	a	9	"	"	u	11	"	n		
	HIH TEMP °F	100	46	88	84	80	84	96	74	72		
GINE.	HOMB HIPSSS PRESS SCHLES GARGE	72		54	46	40	38	48	81	01		
NEEN	LOM DON BANKE	es tu	ŧ	*	*	•	٠,	:	•	3		
1	1	L .	47	46	46	47	48	44	47	47		
10 H.P. OTTO GASO.	H.P.M.	310	310	312	311	313	311	द्ध। ह	318	314	,	
10H.P.	TIME	P.M.	2:54	2:56	2:58	3,00	8.0 2	3:04	3:06	3:08		



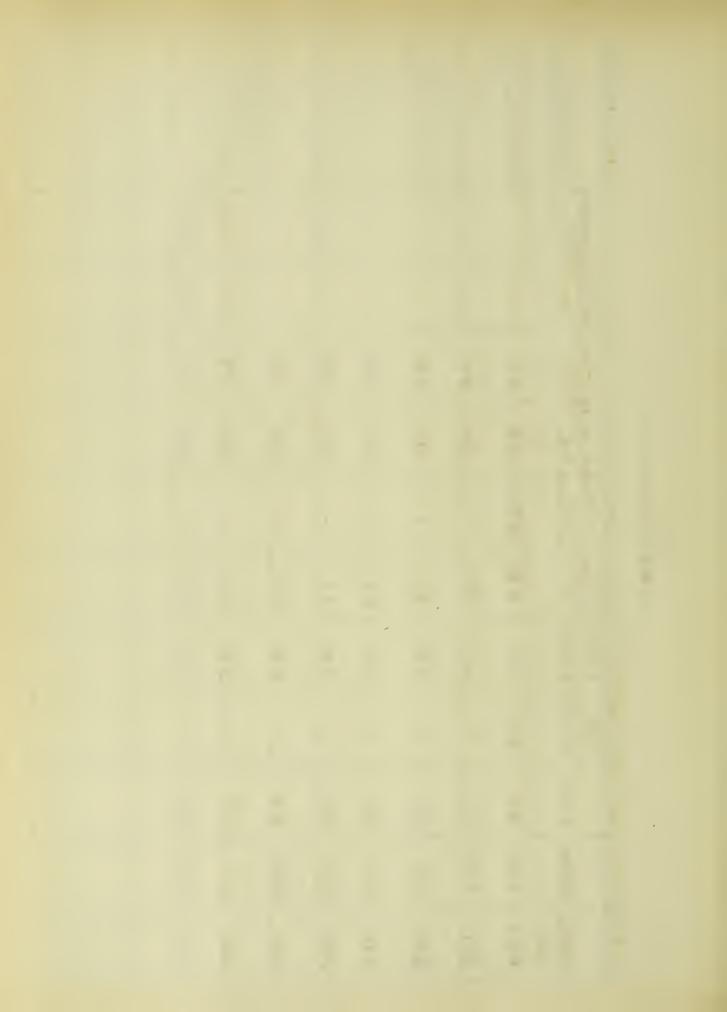
37. DATA SHEET

April 11,1905.		REMHRKS.		Gasoline=1.12#									
h	WHTEF	CHT.									932		
	WTOF	CYL.									#/2		
	TE F.	CAL	'n	90	06	06	90	06	06	16	06		
FST.	TEM POF WATE	CVL.	Jo	120	22/	122	221	120	156	156	091		
2H.PTEST.	TEM	ENTERING CYL.	40	64	ž	"	11	"	,,	"	"		
	HIA TEMP.	70		98°F	40	06	98	or N	84	82	08		
GINE.	HORD AIR BABKE PRESS	"GAGE		62	0	48	68	33	58	61	15		
INFEN	LOAD ON BRAKE	SC ALES" GAGE	,	6 35 #	ż	n	"	"	"	"	u .		
7		EP.M.		29	89	65	69	69	89	99	99		
10H.P. OTTO GRSO		R.P.M.		310	3/2	309	112	308	3/2	318	311		
IOHE		TIME.	P.M.	2:32	23.4	23.6	85.3	2:40	2.42	2.44	246		



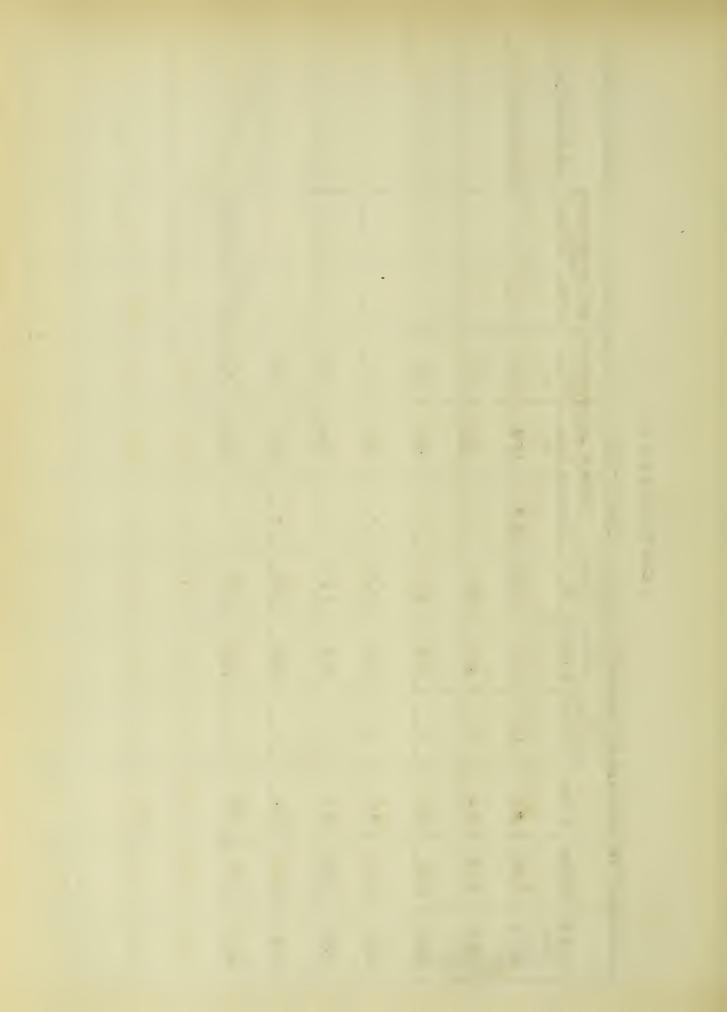
38. DATA SHEET

April 17, 1905.			2 Gasoline = 1.5*									
	T OF WHIER									51*		
	2 2									77		
	VA TER	4	93	94	46	95	95	95	0	96		
TEST	TEMPOFY	o.F	જ//	114	115	9//	811	6//	120	121		
PH.P. TEST	3	,	30°F		"	"	u		*	2		
	AIR TEMP °F		90	90	86	82	78	96	74	72		
INE.	AI B PRESS *GAGE	*	10	00	52	45	38	30	23	9/		
11	HD HKE HKE	*	व्याद	,,	"	"	11	u u	n	u		
H S 041	F.F.M.		54	55	55	55	55	8.3	59	64		
10H.P. OTTO GASOLINE	H.P.M.		3/8	308	311	310	3/2	309	311	313		
10H.P.	TIME	P.M.	2:30	22.2	2:34	236			242	2:44		



39. DRIR SHEET

April 11,1905.	REMARKS.		Gasoline= 1*								
	WHIER								9/.5*		
	WT. OF P								57*		
	HTER VING CAL.	to	98	86	98	87	88	88	88		
TEST	POFY	Jo	122	124	126	130	138	130	132		
3H.P.1	TEN	10	64	<i>"</i>	"	"	"	'II	"		
	HIR TEMP °F		102	94	16	88	98	48	82		
INE.	AIR PRESS GHGE.		00	5/	44	92	68	લ્ય લ્ય	7.5		
IE ENG	LOBD BRAKE, SCALES		#01	ì	"	,	"	"	:		
H SOLIN			80	84	84	84	49	75	72		
OH.P. OTTO GASOL	R.P.M.		309	308	3/2	118	310	3//	3/3		
10 H.P.	71ME.	P.M.	2:09	ોં	5. J.	ان ار	7/2	9:19	્ર સંસ		



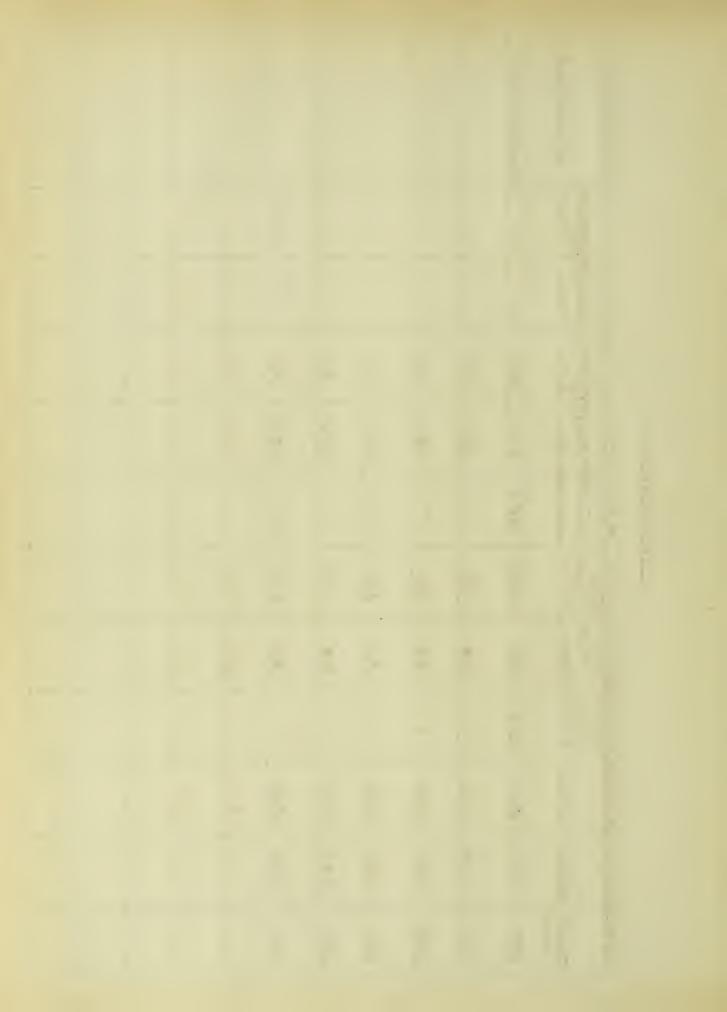
40. DRTHSHEET

April 17,1905.	2400 W 30		* Gasoline= 1.26*									
	C F WHIER										57*	
	WTOF	ì				,					# 98	
	NATER	•F	98	87	88	89	06	16	91	92	₹6	
EST	LEAV	oF.	109	112	115	118	121	123	124	125	921	
SHPTEST	TEN	EN LEINE	58°	и		и	u	••	14	11	u	
	HIR TEMP		84	PZ	80	77	96	74	72	14	04	
SINE.	HIR PRESS.	TH GE.	21	09	24	47	04	88	58	81	//	
NEFN	BAHKE PRESS.		#01	"	"	"	4	"	4	"	z.	
GASOLI			80	76	14	14	. 78	84	26	84	76	
0770		7. 7. 7.	303	315	312	308	3/9	3/4	3/2	309	3/3	
10 H.P.	} 7	P.M.	2:05	2:07	80.8	11:8	213	2.15	2:17	· 6/: ब	/સ:સ	



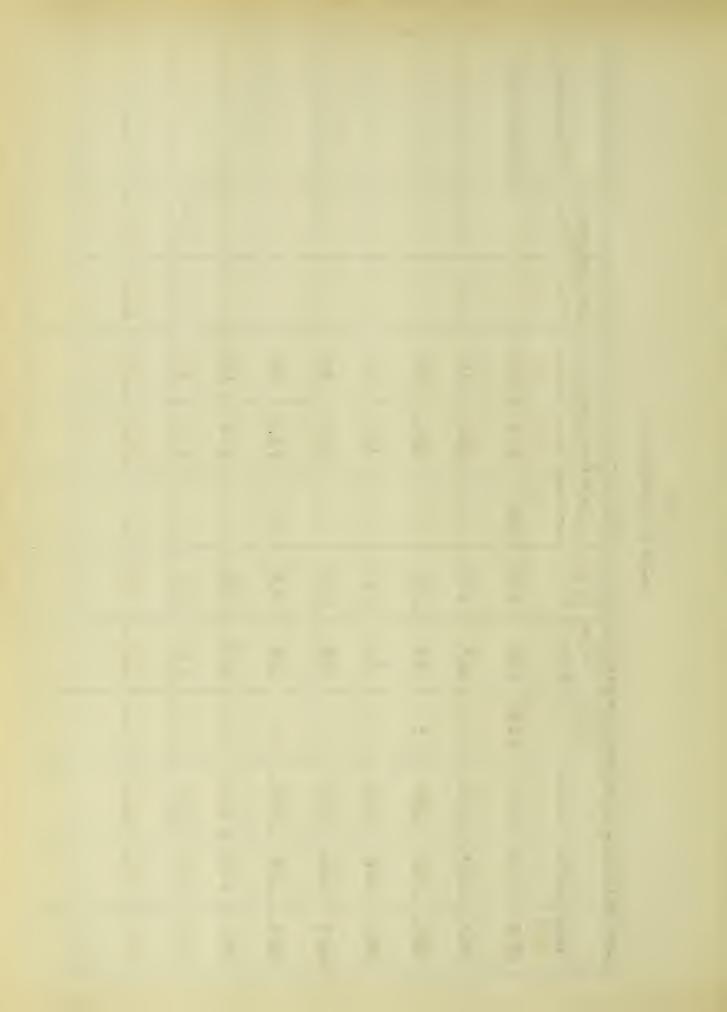
41. DRTH SHEET

April 11,1905.		REMHRKS.	*	Gasoline = ,46								
h	WT. OF WATER	.7H2							67.75			
	WTOF	077							46#			
	HTER	CHL		80	000	80	82	82	82			
EST.	POFW	710	o F	110	120	यय।	431	821	130			
4 H.PTEST.	TEMPOF WHIER	EKTERING	,	687	\.	"	"	"	. "			
	MIA TEMP	į		88	8	84	82	82	80			
NGINE	PRESS.	GHGE.		52	754	ы Ф	3/	45	17			
INEEI	LOR II BRAKE	SCHLES		133#	ì	*	u	5	4			
64501		E.P.M.		105	105	104	101	103	201			,
H.P. OTTO GASOL		R.P.M.		306	308	309	307	309	309			
10 H.P		TIME	P.M.	1:44	1:46	84:/	1:50	1.52	154			



48. DATH SHEET

Hpril 17, 1905.	REMARKS.	Gasoline = 1109									
	WI OF WATER								2/#		
	WT OF								85#		
	NO.	84	80	80	81	81	82	83	84		
FST	TEMPOFWATER	107	9//	123	127	131	133	134	135		
4H.PTEST.	TEMP. OF LER	9 F	:	"	"	"	"	"	"		
	HIR TEMP °F.	88	€ 00	78	76	74	73	72	70		
NE.	PARESS.	6.9	1	52	45	62	ଷ୍ଟ	es 4	15		
E ENGI	LOAD ON ALESS SCALES GAGE.	# 7 2 /		"	n	н	и	:	'n		
HSOLIN	E.P.M.	83	84	8	38	86	ಷ 6	16	200		
LOHFOTTO GASOLINE ENGINE	R. P. M.	303	307	3//	3/0	962	317	3 0 9	300		
IOHEL	TIME	P.M.	र हा <u>,</u>	134	95%	881	140	1:42	1:44		



43.

April 6,1905	HEMHHKS.		Gasoline = 1.54									
	WATER OM. CH L.										21,*	
	WT. OF										235*	
	HTER ING CHL.	700	70	16	46	96	97	44	49	86	66	
FS7.	TEMPOFY	4	///	120	126	130	135	136	138	140	140	
SH.P.TEST.		9.	00	ï	ţ	u	u	"	"	"	"	
	HIA TEMP		100	94	88	84	08	84	46	73	72	
INE	KO W		1/2	63#	56	48.5	04	33.5	98	08	91	
NEENG	LORD ON BARKE SCRLES	4	163	"	*	u u	"	u	"	"	'n	
H S 0+1	E.P.M.		130	128	188	126	125	127	124	125	125	
OTTOG	TIME RPM. E.P.M. SCALES GAU	0	50%	308	315	322	1/2	3/3	311	314	3/8	
10 H.P.	TIME	P.W.	5/5	1 द्वंध	ಸ ಪ ಗ	3.20 5		329	3:31	3.33	3:35	



44. DATH SHEET

Hpril 6, 1905.	REMARKS.	1	Gasaline= 142									
H	WT OF WHTEH										# 9 9	
	WTOF										240#	
	ATER VING CHL.	9°	100	101	101	96	101	201	201	401	401	
FST	TEMPOE WATER	40	120	125	130	132	821	041	751	140	140	
5H.P. TEST.	FXTERING	40	19	11	4	и	и	h	u	н	"	
	AIR TEMP.		001	98	98	83	64	94	46	72	16	
INE.	LOHD HIP SHRE PRESS SCALE *GAGE		77	63	55	84	04	83	58	81	//	
VEENG	LORD ON BABKE SCALE	¥	16 5) :	"	u	u	"	a	u)	
H50111	E.P.M.		140	137	137	134	130	128	125	126	123	
10 H.P. OT TO GAS OL	P.P.M.		3/4	3/3	509	315	3/2	305	3/2	312	3/8	
10 H.P.	TIME	P.M.	3.44	346	3.48	3:50	3:52	3:54	3:56	3.58	4:00	



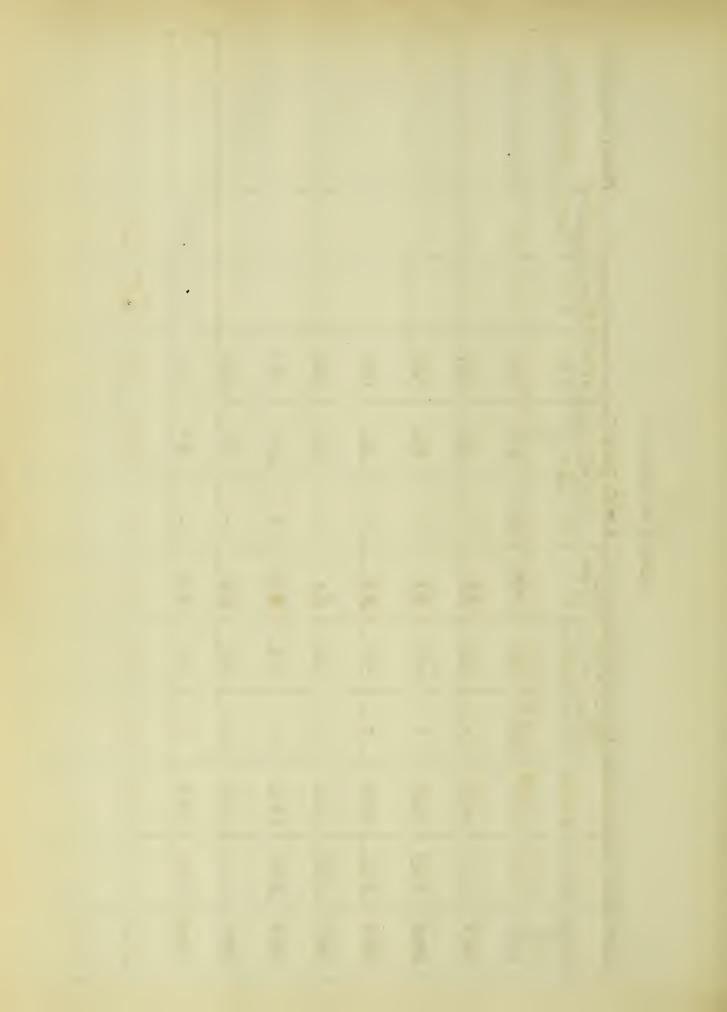
45. DRTH SHEET

April 6,1905.	REMARKS	1	Gasoline= 1.44#									
	WT. OF WHER FROM GYL. CAL.									*84		
										#061		
	TEMPOFWATER		77	72	74	75	92	84	08	18		
EST	POFN	9.	150	150	158	155	091	(66	021	021	Ų.	
6 H.P.T.EST	EN	70	09	u	•	*	2	z	4	1		
	AIR TEMP °F		82	80	28	76	74	73	24	20		
NE.	BARKE #GAGE	!	62	54	46	40	ର ମ	200	17	*		
E ENGI	LOHD ON BARKE SCALES		20*	•	r	z	:	י	:	- 4		
150LIM	E.P.M.		149	151	148	142	140	146	9+1	(48		
TTO GE	LOND HIME PRING E.P.M. SCHLES "GI		309	314	315	ख/ ह	300	3/3	320	812		
10 H.P. 0	TIME	P.M.	2:30	2.32	234	9 5 8	9. 1.0. 4.	2.40	8.4.8 8.4.8	2:44		



46. DRTH SHEET.

April 6,1905.	REMHRKS	Gasoline= 1.3#									
	WATER. MHL.								78*		
	WT OF								\$18		
	ATER VING CAL.	154	156	160	165	091	198	144	145		
TEST	CYL	4.	84	98	86	88	88	06	06		
6 H.P	TEMP	90	1	"	и	"	u u	"	и		
	HIR TEMP	92	86	82	80	82	92	44	72		
NGINE.	PHESS PRESS FGRGE.	63	54	47	40	25	25	81	//		
NEEN	LORD ON BARKE SCALES	20#		u		ž		и	u		
TOGASOLI	2	140	145	140	144	961	641	841	441		
		311	3/4	309	315	3/5	314	112	112		
10 4.10	TIME	RM. R:55	2:57	2:59	3:01	3.03	3.05	307	3:09		



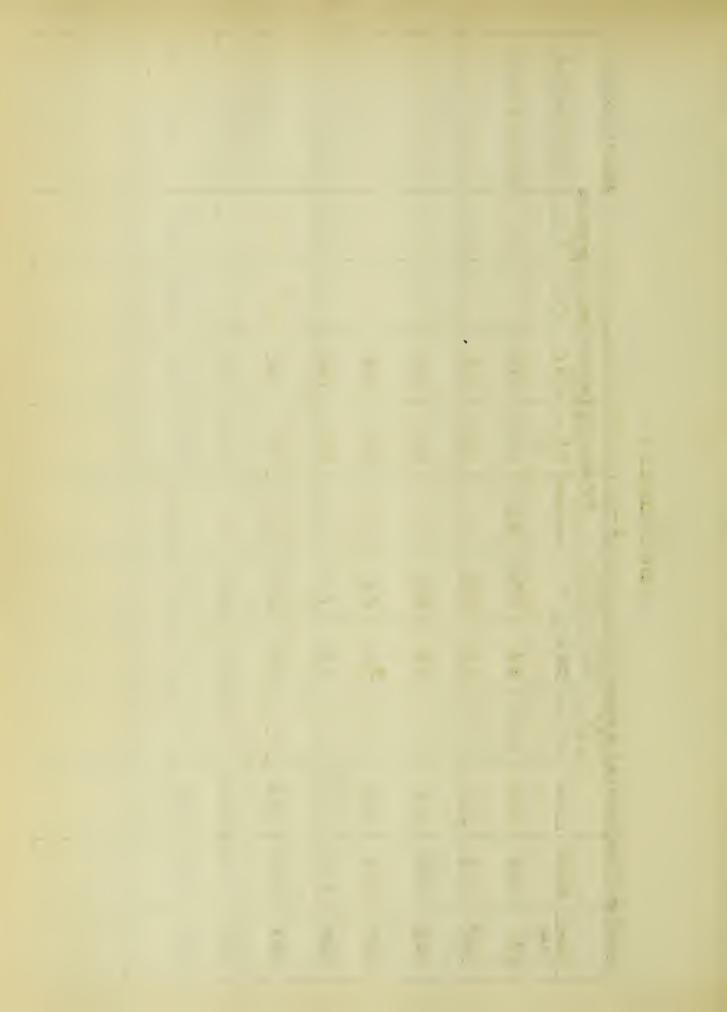
47. DATH SHEET

April 5,1905.	REMHRKS.		Gasoline=1.64									
	WATER										48#	
	WT. OF										#401	
	WATER	40	104	106	107	601	601	601	011	011	///	
EST.	MP. OF LEAV CYL.	40	152	160	164	59/	85/	051	941	561	561	
TH.P.TEST.	ENTERING CYL. CHL. CYL.	40	10	И	39	4	4	n	a a	"	44	
	HIA TEMP °F		104	98	94	89	98	48	82	08	08	
ENGINE.	PIP PRESS. FGRGE		00	56	50	43	35	26.5	61	٤/	9	
INEE	LOAD ON AIR BRAKE PRESS. SCALES*GRGE	#/	かんぶ	14	n	"	"	ŭ	a	"	10	
GHS 01	E.P.M.	1	134	152	155	151	150	153	149	1.53	150	
10 H.P. OTTOGRSOLINE	P.P.M.	(3/5	3/3	3/5	313	3/4	3/3	3/4	314	315	
10 H.P	TIME	TO N.	01/4	3:21	3:23	3:25	3.27	3,29	12:2	5:33	3,35	



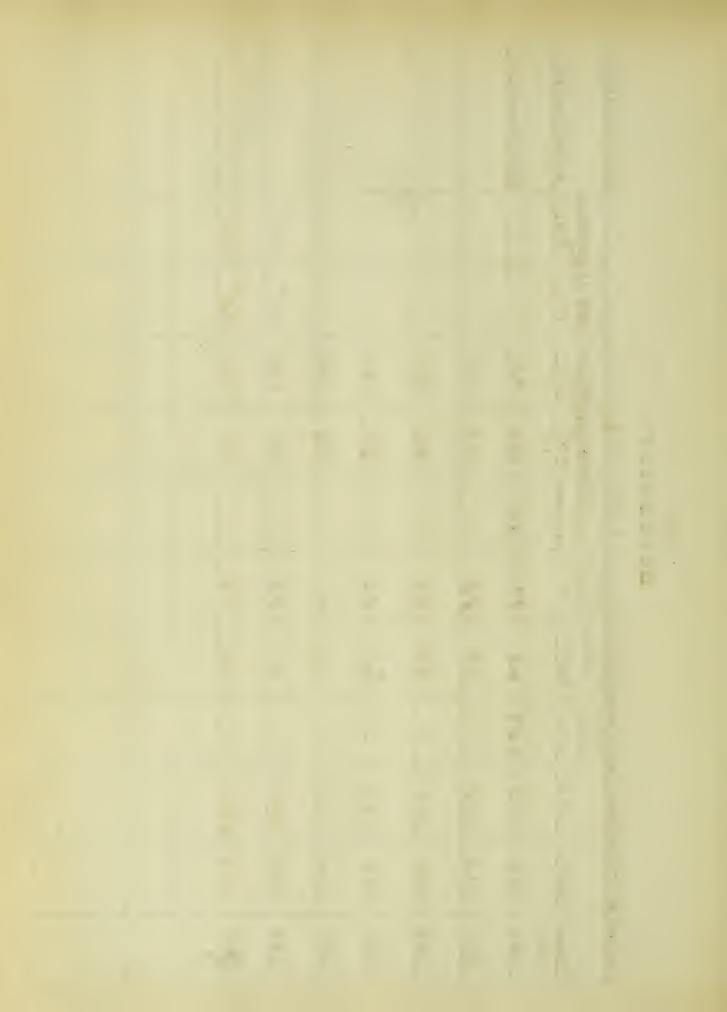
48. DATH SHEET

April 5,1905.	REMARKS.		Gasolina = 1.36									
	WT.OFWHTER FROM.									45*		
	WTOF FR									*301		
	TEMPOFWHIER	40	द्य।।	1/2	//3	1/4	1/4	5//	9//	9//		
	1FOF 1EA CYL.	40	144	146	148	149	150	150	150	150		
IP TEST	HIP AIR TENTE TENTE TENTERING (do	62	и		a	"	"	<i>''</i>	u		
7.4	AIR TEMP. °F.		108	102	94	92	88	84	82	80		
21NE	HIR PRESS #GAGE		65	58	50	43	35	27	20	13		
NEFN	B P B K E # C S C B L E S C		833*	n n	i,	Þ	t	B	ı	"		
			157	150	155	156	155	158	154	156		
10 H.P. OTTOGASOL	R.R.M.		3/2	3/3	3/5	313	314	313	314	314	*	
10 H.P.	TIME	P.M.	3.43	3.4.5	3.47	3:49	3:5/	3.53	3:63	3.57		



49. DATA SHEET

April 5,1905		REMARKS		Gasoline=1.55	,							
	WATER	CAL.							73*			
	WTOF	CYL. CHI.							*0L			
	PTER	CHT.	o F	86	100	101	201	201	201			
FST	1FOFW	CYL.	Jo F	136	154	164	311	921	821			
8H.P.TEST	TEI	ENTERING CYL. CHL.	40	19	"	"	u	۵	v			
	HIR	· FM F		94	90	85	63	18	08			
NE.	HIR PRESS	GAGE		60	45	37	2/	8/	//			
~	ł .	SCALES		26 2 #	s.	ų	"	z	ų			
ASOLIN		E.P.M.		153	150	451	661	150	154			
10 H.P. OTTO GASOLINE ENG		R.P.M.		3/5	3/4	316	3/4	3/4	3/4			
10 H.F.		TIME	.Wid	2:55	3:00	308	3.05	3:07	3.09			



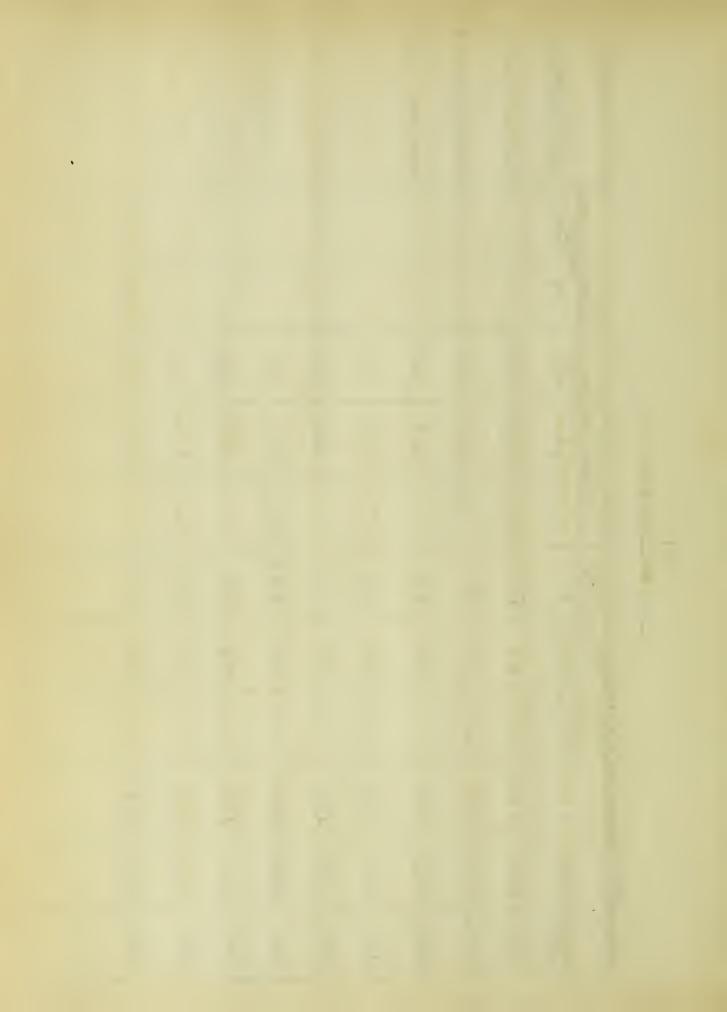
50. DATH SHEET

April 5,1905.		REMHRKS		Gasoline = 2.12#								
	WATER	CYL. CHL.								73#		
	WTOF	CYL								#84		
٠	ATER	CAL	9.	06	6	92	94	95	96	96		
8H.P.TEST.	TEMPOF WATER	CYL.	r.	136	44/	156	29/	991	170	174		
84.1	TEN	ENTERING	90	000	ŧ	"	и	"	ï	;		
	HIR	oF.		90	00	86	48	83	80	79		
GINE	HIPPESS.	#ABBE		65	57	49	43	19 19	<i>9</i>	8/		
NE EN	BABHE	SCALE THEE		263	=	•	"	· ·	"	·		
H5011		E.P.M.		155	154	158	153	15.2	150	148		
0770	BARKE PRE	P.P.M.		316	3/4	214	3/3	3/4	3/5	3/4		
IOHE		TIME	PM.	2:25	15 Sign	<u>૦</u> લો લો	15i8	හ හ බ	9 6 7	2:37		



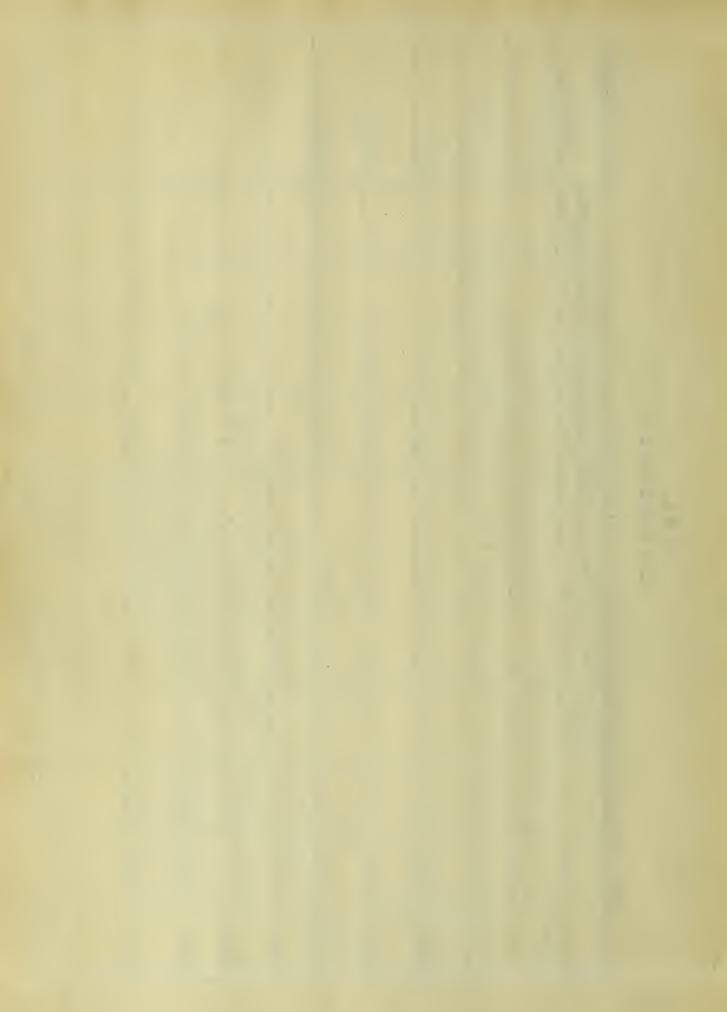
51. DHTH SHEET

Hpril 19, 1905.	REMARKS.	# # 10000000	Fx h. tom n = 84°F	H+mos.tema= 86°F							
H	OF WHTER.									65#	
:	WE									115#	
	VATER ING. CHL.	101	001	102	102	101	101	00/	201	201	
EST.	TEMPOFY		79/	29/	158	921	133	62/	144	861	
9H.P.T.EST	TEM	9. F. A.	,,	u	,,	u	:	"	h	**	
	HIA TEMI	06	88	98	83	28	79 %	64	28	84	
	PRESS. *GRGE	14	19	55	47	42	9	30	24	81	
FENG	LOAD BANKE SCALES	# ~	5	ε	u	ı	=	"	41	и	
W17056	E.P.M.		135	130	127	181	130	124	120	113	
IOH.P. OTTO GASOLINE ENG	R.F.M.		898	998	251	250	243	243	238	022	
10H.P.	TIME	P.M.	ह ते दे		237	න ස	2:41	2:43	2.45	2.47	

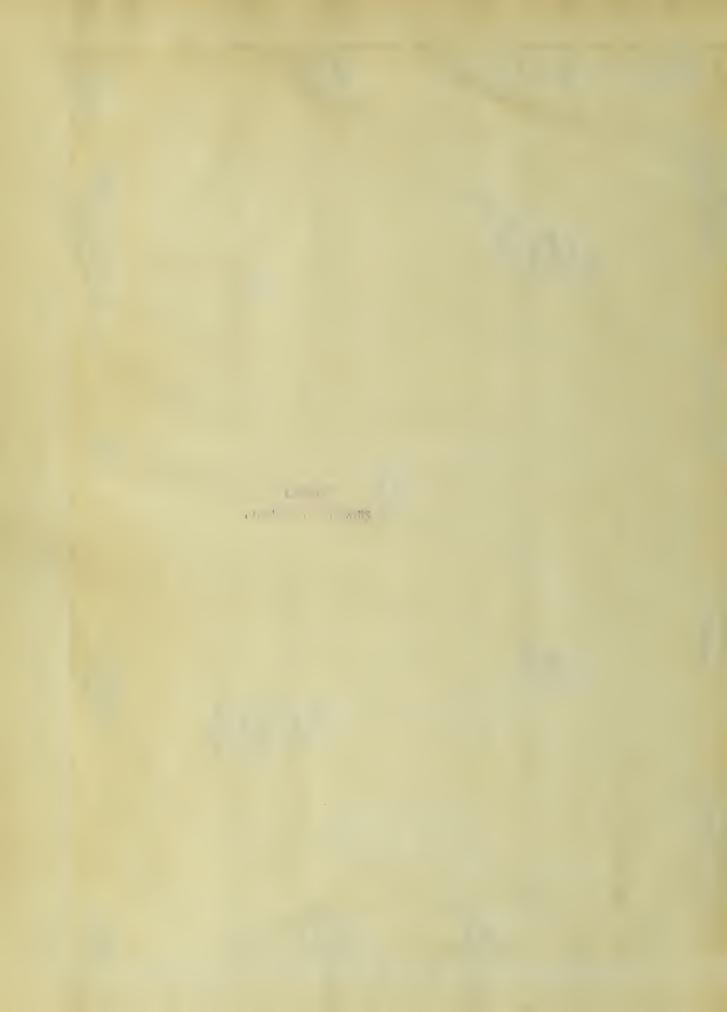


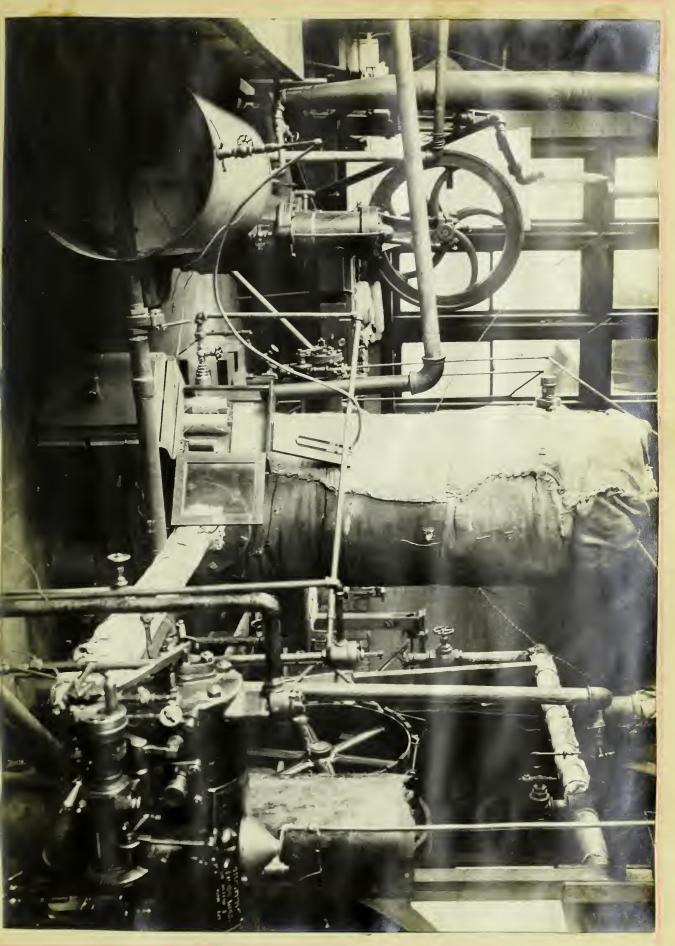
52. DATH SHEET.

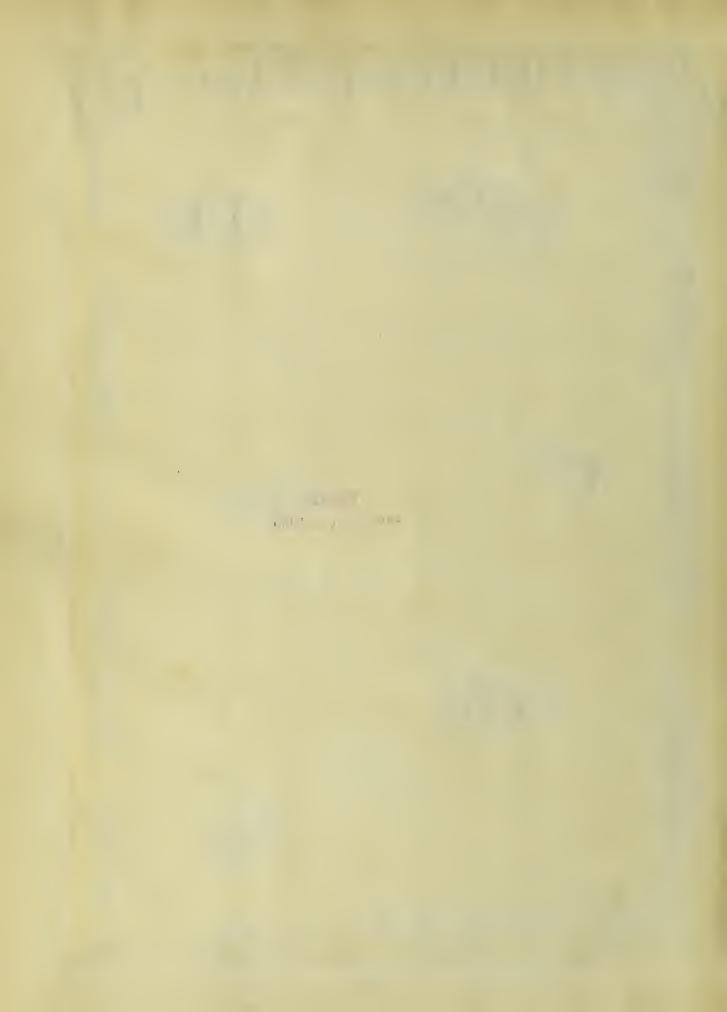
APRIL 19, 1905.	REMBBKS.		Gasoline used=	2.26 #	Tem p. of Exhaust	- 82°F	H+17105.=885°F					
	OF WHIER										#88	
	YE. CYLFAP WALE										# 118.5#	
	320	70	90	85	86	90	16	16	92	26	46	
FST			///	123	126	136	138	138	121	851	62/	
9 H.P. TEST	ENTE	7.	64	, i	"	n	n	"	"	ii	"	
	AIR TEMP. °F.	0	10	98	84	82	80	99	84	44	94	
ų i	PRESS *GRGE.		00	55	49	42	36	32	26	20	15	
ENGIN	LORD AIR ON PRESS BRAKE "GRGE.	1	#00	×		"	II.	n	n	W	н	
SOLINE	E.P.M.		155	137	131	///	12.5	121	11.9	103	97	
10 H.P. OT TO GRSOLINE ENGIN	R.P.M.	(663	256	248	25 S	≥ 3€	235	230	207	188	
10 H.P. 0	TIME	F.M.	7:56	1.58	00;e	છ છે. છે.	2:045	2:06	2:08	2:10	ର ଜ	

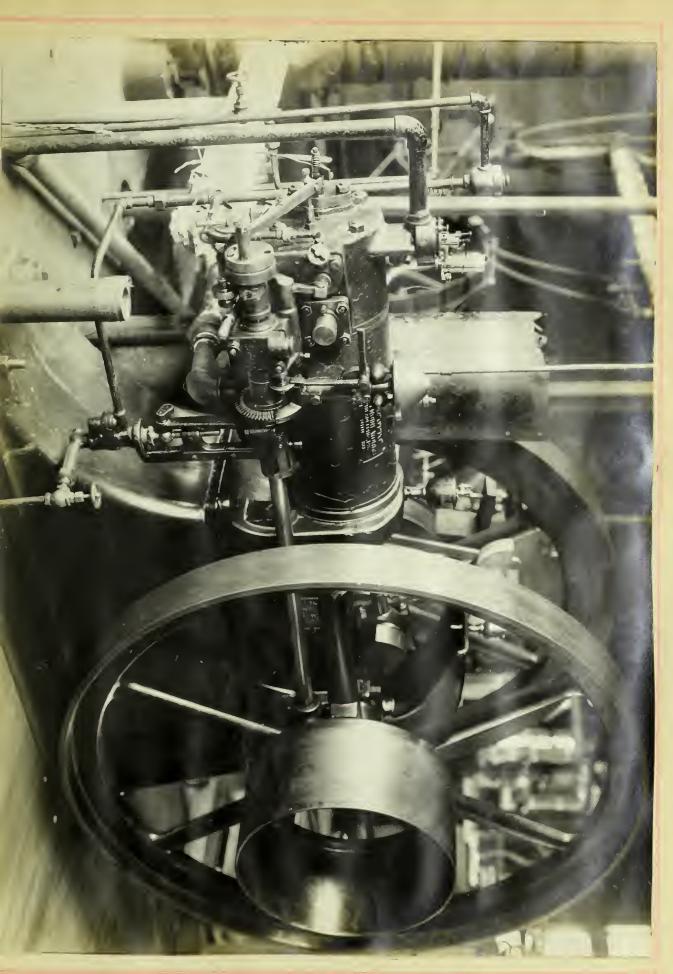


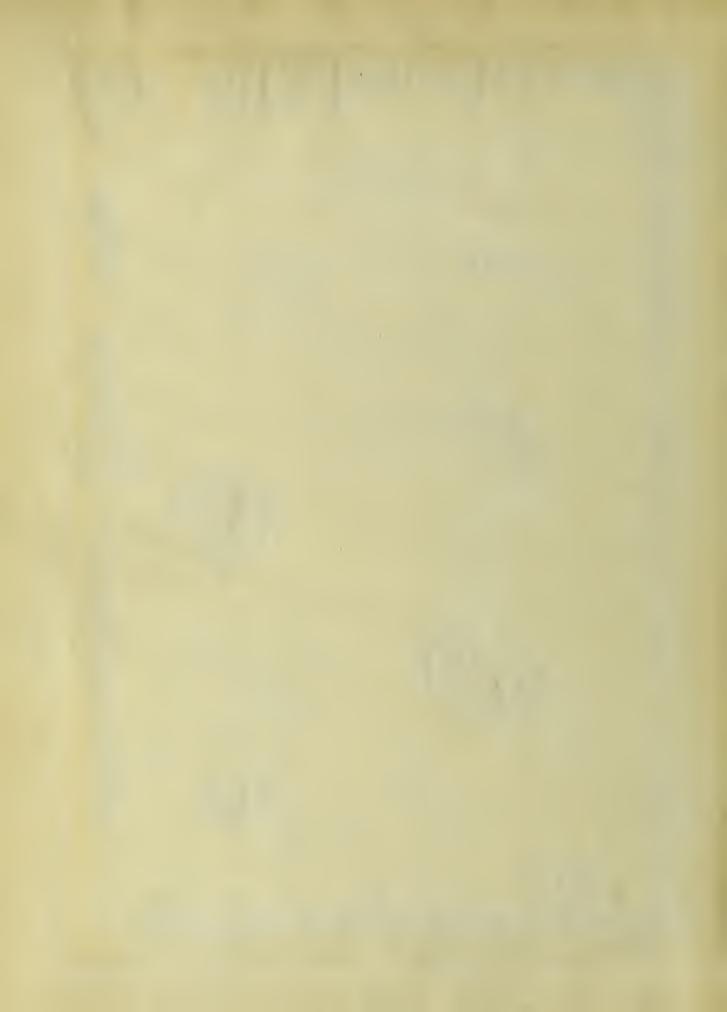


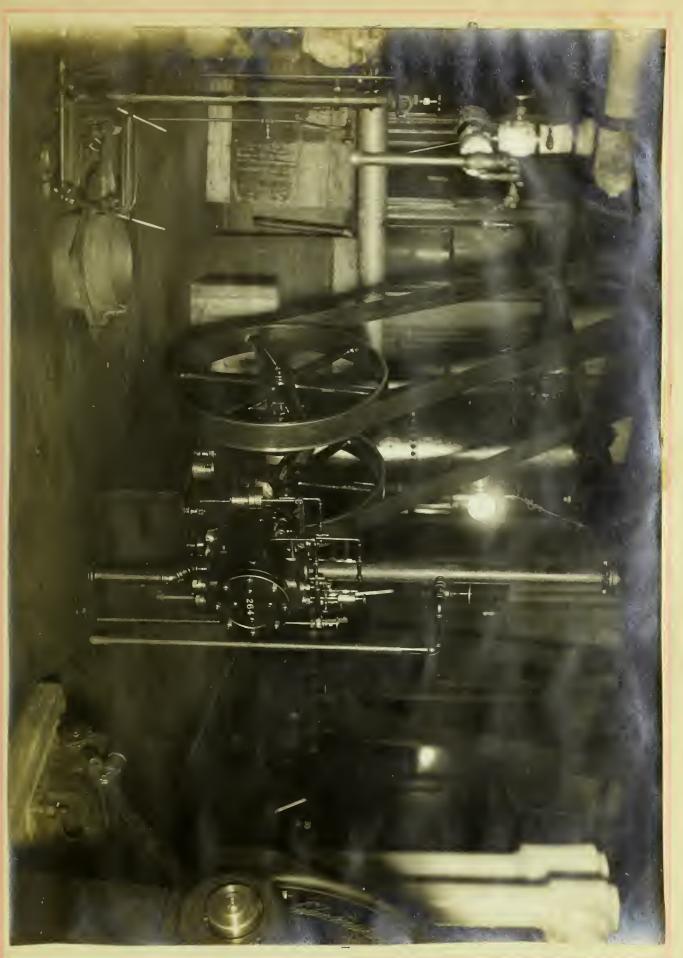


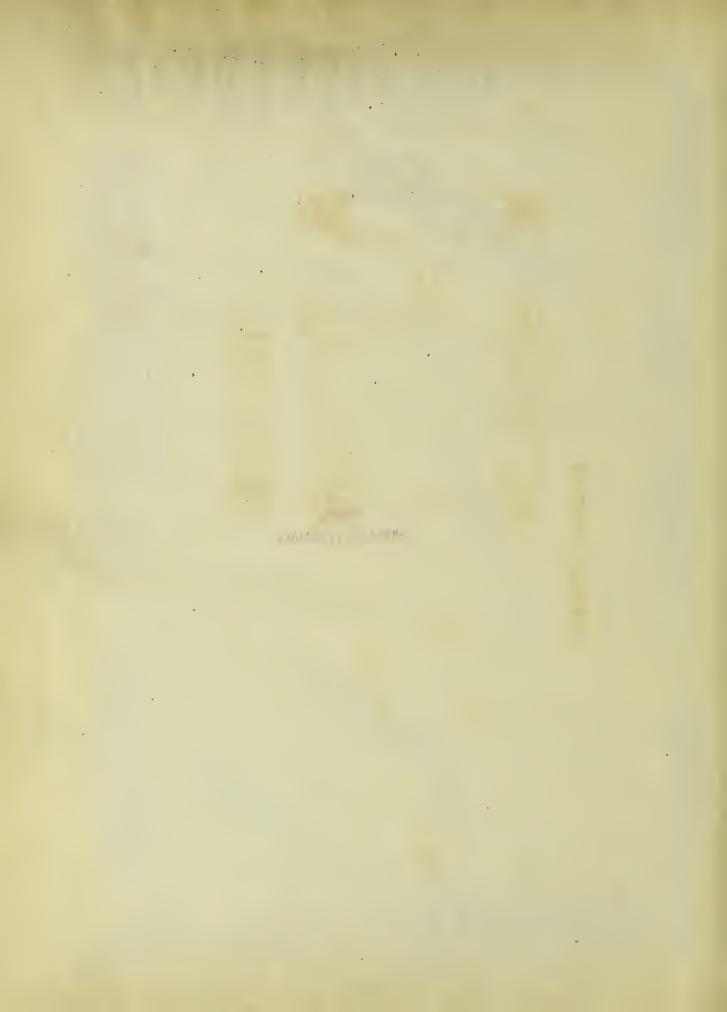


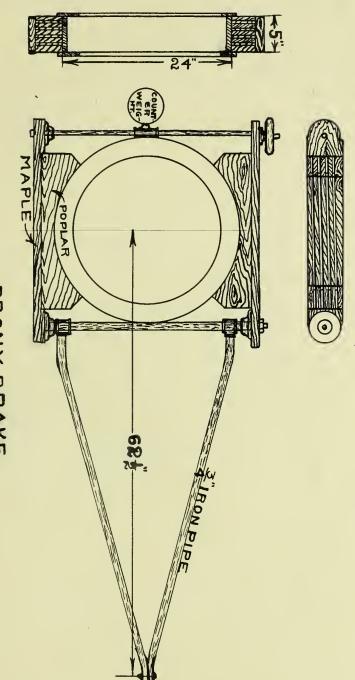












PRONY BRAKE



©

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Otto 10H.P. Gasoline Engine.

Rverage cost per
brake horse

K)

hour

Gasoline at 15 pergal.

65 W cost per B.H.P. Hour in cents. \dot{c}

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